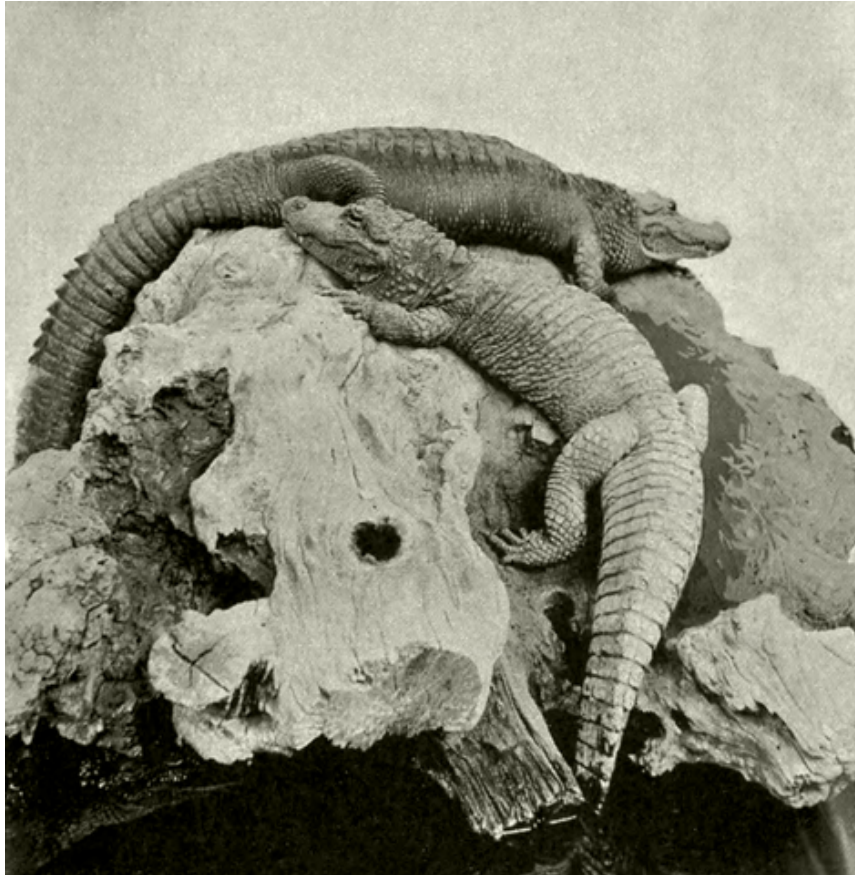


SCIENCE AND SCIENCE FICTION 2

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THE GEOGRAPHICAL DISTRIBUTION OF FISHES.

by Seth E. Meek.

The Project Gutenberg etext of Birds and Nature, Vol. VIII, No. 4, November 1900

There are known at the present about twenty thousand species of fishes, which are distributed throughout the creeks, rivers, lakes, seas and oceans of the world. A few species of the open sea are cosmopolitan; the others are more or less restricted in their range. Northern Asia, Europe and North America have in common a few species of fresh water fishes. There are many others of close relationship, which indicates a somewhat common origin of the fish faunas. The same is largely true of the salt water shore fishes, which live well to the north. The fresh water fishes of South America, Africa and Australia are all different from each other, none being even closely related as are those we find in the countries of the northern hemisphere.

The fishes of our Atlantic coast are different from those of the Pacific, very few species being common to both coasts. The fishes of the Ohio river are entirely different from those of the Columbia, not a single species being common to both streams. The fishes of the Missouri river are very different from the Ohio, many of the larger species, as catfishes, buffalo fishes, black basses, and some of the sun fishes are common to both rivers. The difference between the fishes of these two rivers is chiefly in the smaller kinds, which do not migrate to any great extent, and is greater as you go toward their sources, or confine yourself to their smaller tributaries.

There are many reasons why the fishes of one region are not the same as those we find in another. Some of these reasons we may learn by making a careful study of the fishes of each region, and their environment. In addition we must learn all we can about the past history of the country, finding which streams were formed first, and how they became inhabited from the old ancient fish faunas of our earlier geological periods. If you visit streams in the Alleghanies, the Ozarks and the Black Hills you will find them much alike. All have clear, cool water, flowing over sand or gravel. The black bass, speckled trout, channel cat, and the eastern pickerel will live quite as well in streams of each locality. If you spend a day at each place collecting fishes all your catch will not be the same species. In the Alleghany region you

will obtain about forty species, and a like number in the Ozarks. Of these quite one-fourth, or one-fifth, will be the same species, and the others closely related. A large portion will consist of sunfishes and very small, perch-like fishes, which are called darters. These are spiny-rayed fishes; that is, nearly all of the fins are made partly of strong, sharp spines, such as you find on the back of sunfishes, black bass and the like. In the streams of the Black Hills you will not find more than fifteen species, and not more than one or two, if any, will be the same as in either of the other two catches. There are none of the spiny-rayed fishes in the Black Hills, and no trout, though the streams seem in every way well suited for them. The fishes of the Black Hills consist of two catfishes, four suckers, eight minnows, and one member of the cod family. Why are there no spiny-rayed fishes? If you examine a map you will find that the Black Hills is an isolated region, about seventy-five by one hundred miles in extent. It is covered with heavy pine forests and drained by a dozen or more good-sized creeks, which find, through the north and south forks of the Cheyenne, an outlet into the Missouri river. Surrounding the Black Hills is a broad plain one hundred or two hundred miles in width. It has no forests, and only a scant vegetation. Its streams are alkali and contain much solid matter in suspension. None of these streams flow over rocky or gravelly beds. Like all the streams of the great plains they are overloaded with sediment. All the streams can do with this sediment is to deposit it in places during falling or low water, and in time of freshets, pick it up, shift it about and redeposit it farther down the stream. Such streams are like the Platte, narrow and deep in a few places, but mostly wide and shallow, with a bottom of quicksand. The streams of the plains have in them but few species of fishes; especially is this true of the upper Missouri, and these are such species as we find in the Black Hills. It is thus evident that the fishes of this region migrated there, and only such fishes as were able or willing to live in the muddy, alkaline streams of the great plains could have ever reached the Black Hills. The minnows and suckers are ever preyed upon by sunfishes, bass and the like, and to escape them evidently sought retreat in the alkaline water, which was too much disliked by their enemies for them to follow. Once there and accustomed to such water they would migrate farther up stream until they reached the clear, cool streams of the Black Hills. If we compare the fishes of two rivers whose mouths are near each other, as the Ohio and the Missouri, those fishes found near the mouths will be the same species and the two river faunas will differ most as you go toward their sources. On the other hand, if you select two rivers whose sources are near each other, as the James and tributaries of the Ohio, then the fish faunas will differ most as you go towards their mouths. The same is true of the Missouri

and the Columbia. In such cases it often happens that during high water some fishes are able to pass from the head waters of one river basin to the other, just as we see the trout from the Columbia at the present time colonizing the upper Yellowstone through the Two Ocean Pass. Near the head waters of many mountain streams there is usually a pass, which contains a strip of meadow land where the small streams from mountains unite, forming the sources of two great rivers flowing in opposite directions. This is the case both at the Two Ocean Pass, the source of the Missouri and the Columbia, and at the point where the Canadian Pacific Railroad crosses the divide, forming the source of the Frazier and Saskatchewan rivers.

Many mountain streams whose sources are at present in no way connected may have been so at no very remote period. All of our streams which have their sources within the glaciated area were no doubt connected as the ice receded. The drainage of Lake Champlain and the lakes in central New York was southward at the close of the glacial epoch. It is said that in times of high water one may pass in a skiff from the head waters of the Mississippi to the Red River of the North. With such facts before us we can easily understand why the fishes of two rivers whose sources are near each other should be most nearly alike nearest the divide. If the two rivers were formed about the same time, as no doubt were the James and the Ohio, they would naturally have several species in common. In other words, the two fish faunas will resemble each other throughout their whole extent. In the case of the Missouri and the Columbia, the former is much the older stream, and while their sources have fishes common to both streams, in the lower parts of the rivers the fish faunas are entirely different. The upper Missouri river and its tributaries are for the most part inhabited by Rocky Mountain fishes, practically the same fauna as we find in the Columbia, but few species characteristic of the Mississippi valley have been able to even cross the great plains and none have ever passed the Rocky Mountain divide.

In the study of the geographical distribution of our fresh water fishes, we are able to make a few generalizations as follows: Two rivers in the same latitude, and belonging to the same great drainage basin, and draining similar areas, will have similar fish faunas. Thus we find a great similarity in the fishes of the Washita and the Tennessee rivers, a much greater similarity than we do in the fishes of the Washita and the Cedar rivers. If the stream is a large one, the fishes near its source will be much unlike those near its mouth. The fishes of Minnesota differ greatly from those of Louisiana, though the drainage of these two States is in the Mississippi river

basin. Limestone streams have in them more species of fishes than do sandstone. All things being equal, the larger of two or more streams will contain the most species of fishes. There are few, if any, rivers as rich in species as the Mississippi river and its tributaries. It drains one slope of each of our two great mountain systems, besides an immense area of wood-land and prairie, and numerous swamps and marshes. Its upper course and many of its upper tributaries lie in the region once covered by glaciers, though now traversed by great moraines. Its fishes are as diversified as the area it drains. In its mountain streams we find such fishes as the trout, darters, minnows and suckers. In the upland streams are darters, shiners, suckers, sunfishes and small-mouthed black bass. In the channels of the larger tributaries are found the large suckers, buffalo fishes, gar pike, channel catfish, drum, pike and pickerel. The lowland streams contain the dogfish, pirate perch, some sunfishes, the large-mouthed black bass, some suckers, catfishes and other species. Minnows, darters, suckers and sunfishes are found in lowland, upland and mountain streams, though not the same species in each. These fishes belong to families which are made up of many species, some being strictly upland, others strictly lowland, each having a limited range. In the same way we have fresh water fishes and salt water fishes; some fishes, as the trout and salmon and eel, live in both salt and fresh water. Many other fishes, as the killifishes, thrive best in brackish water. Each species of fishes is best fitted for a particular region into which it has been forced to live, either to escape its enemies or to be able to get a living easiest. In its migrations it has moved along lines of least resistance, and has colonized those streams where Mother Nature has been able to do the most for it. The darters are small, perch-like fishes, which seldom exceed a length of six inches, the average being about three. All are active and swift swimmers and well suited for a life among the rocks and swift water of our smaller streams. All countries have small, swift, rocky streams, but few have darters. In their stead we find loaches, gobies, characins, sculpins, and the like. These fishes have "become dwarfed and concentrated, taking the place in their respective habitats which the darters occupy in the waters of the Mississippi valley. By the same process of 'analogous variation' the cichlids of South America parallel the sunfishes of the United States, although in structure and in origin the two groups are diverse."

Dr. Jordan tells us that the trout of the Pacific coast came to America from Asia, and gradually spread eastward and southward until now it is found in all the streams of the Rocky Mountains, the Sierra Nevada, the Cascades and the Coast range. It is but a short distance from Kamchatka to Alaska, and this distance is traveled by trout to this day; once

over, a fish able to spend much of its time in salt water could easily colonize all our coast streams. Whether or not all of our Pacific trout are descendants of one species, the cut-throat trout, is more or less uncertain, though it is quite certain that all have descended from not more than two or three species. In many places they have been able to pass from the head waters of one river to that of another, just as they now pass from the head waters of the Columbia to the Missouri by the way of Two Ocean Pass. The ancient lakes, Lahontan and Bonneville, no doubt assisted them in their migrations. Since these have disappeared each colony has had to remain more or less isolated. In time they have become somewhat changed, to better adapt themselves to their new environment. These changes have developed certain peculiar characters, by means of which we can distinguish one kind of trout from another, just as the farmer distinguishes his Berkshire from his Poland China. Spread, as the trout are, over such a large area, in such an immense variety of streams and lakes, and with a vertical range of over one thousand feet, we would certainly expect as large a number of species and varieties of trout to be developed as we find at present in the streams of our west coast.

Fishes are found in the deepest parts of the ocean. Some of these are peculiar to the deep waters, none of the shore fishes resembling them. On the other hand, many deep sea fishes belong to families well represented in the shallow water. The flounders are found in water at all depths, and the same is true of the bat fishes, rock fishes and other shore fishes. It is easy to understand how these fishes have found their way to the deep water. It was either to escape their enemies or to extend their range for some reason; as Mr. Garman puts it, "They have slid down," as it were to the bottom of the ocean.

In general, animals migrating will always move along lines of least resistance. Some deep-sea fishes have a considerable vertical range. It is thought that some move into shallower water to deposit their eggs or place their young in warmer water, and where the peculiar kind of food they need early in life is the most abundant. To study deep sea fishes is difficult, and so little has been done that we not only know them imperfectly but also know very little concerning their life histories.

In February, March and April of 1891 the United States Fish Commission steamer Albatross explored a portion of the region between the coasts of Mexico and Central America and the Galapagos Archipelago. Besides obtaining a large number of shore fishes, about nine hundred specimens of fishes were secured, ranging from a depth of one hundred to twenty-two hundred and twenty-three fathoms. This collection was

carefully studied by Professor Garman, of Harvard. He found the collection to contain one hundred and eighty species, eighty-five per cent. of which were new to science. The bottoms of the oceans are far from level, and each deep basin has its own peculiar fauna. The shallower parts of the sea prevent migration of the deep water forms and no doubt living as they do in eternal darkness and in a temperature near the freezing point, there is little to induce them to much activity. The fact that they are easily captured in nets of comparatively small size would indicate that they move about slowly.

Dr. Jenkins, who has lately studied the fishes of the Sandwich Islands, informs me that less than five per cent. are found on our American coast, while a large per cent. is found all the way to the Red sea. In other words, the fishes of the Sandwich Islands are East Indian rather than American. This is no doubt caused from the fact that the deep water between the islands of the American coast forms a barrier which has always prevented the two fish faunas from mingling with each other. Between Africa and the Sandwich Islands this has not been the case. A recent study of the fishes of the Galapagos Archipelago shows its fauna to be American, though in what respect its fishes differ from those of our west coast they resemble all the more the fishes of the Sandwich Islands. Two fish faunas will usually differ from each other if separated by an impassable barrier; especially is this true if the barrier be older than the two faunas.

Any barrier which prevents or hinders fishes in their movements from one body of water to another will separate two more or less well-marked fish faunas. These barriers may be mountains, or shallow water, as in the case of deep sea fishes; deep water, as in case of shore fishes; muddy or alkaline water, or water of different temperature. Temperature no doubt has far more influence in governing the movement of fishes than is generally believed. It plays an important part in guiding salmon up stream to their spawning beds. It explains why they reach the head waters of some streams and spawn earlier than in similar streams not far distant, but of different temperature. If you would know to what extent fishes of one region differ from those of another, study well the barriers between the two regions, learn to what extent and how long they have existed, consider the age geologically of the two regions, and how fishes may have migrated to one or the other, and in a general way you will have the key to the situation, which a careful study of the fishes is quite sure to verify.

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FISH FRY

By Arnold Marmor

Lots of strange things happen at sea. But
this was a new twist, a fish that really wasn't
a fish at all. So the question, who hooked what?

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Off Key West in the Florida Strait, with the bucking of the motor launch under the seat of my pants, and a rod and reel in my hands, I could relax. I mean really relax. Sometimes a cool current from the Gulf of Mexico would engulf me and it would be like something a man dreams about. Alone, under a blue sky, with one's thoughts. And then the thoughts would vanish as that familiar tug on the line meant a struggle was coming up. A battle between man and fish.

I love deep sea fishing. I was on a vacation with nothing to do but relax. Oh, there were women, all right. But one gets tired of women. But not fishing.

So here I was, this bright sunny afternoon, in my motor launch, when that tug on my line made me sit erect, and my brain became alert. You have to think clearly. You have to know when to let out line and when to pull in line. When the fish got tired you could tell. It all comes through experience.

From the pull of the line I thought I'd hooked a sailfish.

I reeled in fast, then started letting out line. But the line didn't get taut. It was loose. At first I thought I'd lost it.

And then it climbed into the launch.

I got up fast and made ready to dive overboard.

"Hold on, fella," it said. "Don't get into a panic."

I stared at it. It was about four feet tall, with scales and two thick stubs that was supposed to be tails. It stood on its tails and blinked enormous eyes at me.

"The creature from the black lagoon," I said.

"To you I'm a creature," he said. "To me you're a creature."

"What kind of a fish are you?"

"I'm not a fish. I'm a Grenarian."

"You mean you eat vegetables?"

"I'm from the planet Grenaria."

"Look," I said. "You want this boat? Keep it. I'm off for Tampa. It's about time I took up drinking."

"You hate me."

"No, I don't. Honest. I'm just not used to these things."

"It happens all the time. What you don't understand you hate."

"But I don't. Honest. And where did you learn to talk?"

"I learned English from a professor. He understood my plight and tried to help. He was fishing the same as you when I caught hold of his line and we met."

"What happened to him?"

"He went back to tell his colleagues. I never saw him again."

"He's probably in the booby hatch," I said.

"What's that?"

"Where I'll be if I ever tell anyone this."

"This is a cruel world," he said. "By the way my name is Hrodes."

"And mine is Carol Engelholtz. Now that the formalities are over, what the hell are you doing here?"

"My orders were to make contact with this solar system. My ship is at the bottom of the sea. I have to be near water or die. And every time I try to make contact I'm left alone on a craft of this sort."

"You mean they jump overboard?"

"That's exactly what I mean."

"You're from another galaxy?"

"Yes. My planet is covered with water. Your planet is the best one in this system which has water on it. That's why I'm here."

"But you're not in water now."

"My gills can still absorb it. As long as I'm near it."

"Well, what do you want me to do?"

"I want to meet someone with responsibility."

"I wouldn't be able to get anyone to come out here with a story like that. They wouldn't believe me. I'd end up with the professor."

"Then take me with you."

"But you wouldn't be near water. Wait a minute. I can leave you in the tub."

"Anything. I just want to get this mission over with."

"I can wrap you up in wet towels. I can drive you to my place and go bring someone back with me."

"Anything. Anything. Just let's get on with it."

"Why, I might be making history. I may become famous."

"Will you please start this craft back to land?"

"Sure thing. Just a second," I started the motor and headed for land.

Me. Carol Engelholtz. A liaison between two planets. I never felt so excited in my life. Why, it was more exciting than hooking a sailfish.

"There's my lodge," I shouted, pointing at the bluff just over a rise.

"You stay there alone?" Hrodes asked.

"I have a cook and a housekeeper. But they won't bother you. You'll stay in the tub in my bathroom while I go fetch somebody. But who do I go fetch?"

"Anyone with responsibility. I want to get this over with."

"Yes, yes, I know. Your mission." I docked the launch, soaked towels, wrapped them around Hrodes, carried him--or she--to my car, and in fifteen minutes I was home.

* * * * *

I left Hrodes in the tub and went back to the car. Miami was too far off. There was a small town called Chesterville a few miles away. It seemed the only place to go.

"There ain't no F.B.I. branch here," a deputy behind a battered desk said. He was about sixty, with a skinny neck that was covered with half dollar size blotches. "Better try Miami. Why? What's the matter? Find some subversives? A lot of subversives in Florida."

"No, no, nothing like that. Look, there must be a school or some kind of place for learning here."

"Shore thing. We gotta school."

"Isn't there a professor teaching there, maybe?"

"Nope. But we got old Mrs. Henshaw. Husband died about six years ago. Old bag. I think she's been running around lately with some tourist from Iowa. Now if you're just lookin' for any old professor, then--"

"That's right," I said, grasping at a straw. "Any old professor. Is there one in town?"

"Professor Klugelmeyer. Used to teach at some eastern college. Kind of dopey, though, I think. Funny old gaffer. Believes in flyin' saucers. Can you imagine?"

"Where do I reach him?"

"He's stayin' at Mrs. Kirpatrick's roomin' house. Poor Mrs. Kirpatrick. Got a bad case of food poisoning. She ate--"

I ran out of the building and inquired for the rooming house. I found it and Professor Klugelmeyer.

"What? What? Hard to believe--Hard to believe. Once heard the same story from Professor Dickson. The poor fellow was put away. You must be mistaken, old man. You must be. Take my advice. Give up drinking. Bad for the liver, too, you know."

"That old deputy told me you believe in flying saucers," I said.

"I do. I really do. From Mars, probably. But they certainly won't turn out to be fish. Fish talking? Come now."

"I didn't believe it at first myself. Listen, Professor, come with me. See and hear for yourself."

"Well, I don't know."

It took me an hour before I had him half convinced. I almost dragged him to my car.

"This had better not turn out to be a practical joke," he said. The professor was somewhere between sixty and seventy. He was kind of thin and he sported a long white mustache.

It was getting toward evening when we got to the lodge.

I ushered him in to my room. "There," I said, flinging open the bathroom door.

"Where?" he said.

"There."

"Where?"

I looked. I blinked. I looked again. The tub was empty.

I raced through the house.

In the front room I saw Mrs. O'Brien, my housekeeper.

"Where's Hrodes?" I asked her.

"Who?"

"He was in the tub. I left him there."

"You mean that big fish?"

"Yes, yes. Where is he?"

"He's in the kitchen. We're having him for dinner."

"What!"

"Sure. Yat has it in the oven now."

"You murderer!"

"What are you talking about? It's only a fish. Didn't you catch him so we'd have fish for dinner?"

"No. Didn't he tell you who he was?"

"Are you crazy? He didn't tell me nothin'. Besides, I didn't see it till Sun Yat had it all cut up and laid out for cookin'."

Sun Yat, my Chinese cook. Hrodes had met someone who couldn't understand his plight or be scared out of his wits. Sun Yat was a deaf mute!

The professor was clucking sadly at me as he stomped out of the house.

Me? There was nothing to do but eat my dinner....

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THE DREAM JEWEL

The tribe of the sturgeon was speeding southward over the rock-strewn floors of the inland sea. In the van of the swimming host its leader bore a wondrous stone. From it multicolored beams flashed out through the dim waters and into unsounded depths. Shapes, still and ghostly, with waving fins and solemn orbs, stared at the passing glow and vanished. Phantom-like forms faded quickly into dark recesses, and frightened schools of small fish fled away over pale sandy expanses. Clouds of fluttering gulls and terns followed the strange light that gleamed below the waves. Migrating birds, high in the night skies, wheeled with plaintive calls, for this new radiance was not of the world of wings and fins.

The wonder stone was being carried out of the Northland. For ages untold it had reposed in the heart of a stupendous glacier, that crept over the region of the great lakes from the roof of the world--from that vast frozen sea of desolation that is ghastly white and endless--under the corona of the Northern Lights.

From a cavern deep in ice, its prismatic rays had illumined the crystal labyrinths during the slow progress of the monster of the north, grinding and scarring the earth in its path of devastation.

The radiance from the stone was ineffable. Such color may have swept into the heavens on the world's first morning, when the Spirit moved over the face of the waters, or have trembled in the halo at the Creation, when cosmos was evolved out of elemental fires.

It glowed in the awful stillness of its prison, untouched by the primeval storms that raged before the mammoths trod the earth, and before men of the stone age had learned the use of fire.

Many centuries after the greater part of the gigantic ice sheet had yielded to balmy airs, its frowning ramparts lingered along the wild shores of the north. The white silence was broken by reverberations from crumbling masses that crashed down the steeps into the billows that broke against the barrier. In one of the pieces the stone was borne away. The luminous lump drifted with the winds. It was nuzzled by curious rovers of the blue waters that rubbed gently along its sides and basked in the refulgence. With the final dissolution of the fragment, the stone was released.

In quest of new feeding grounds, the sturgeon had explored these frigid depths, and, after privation and fruitless wanderings, had gathered for the long retreat to a warmer clime. Their leader beheld the blazing gem falling, like a meteor, before him. With fateful instinct he seized it and moved grimly on. The gray horde saw the light from afar and streamed after it, as warriors might have followed the banner of a hero.

Through many miles of dark solitudes the bearer of the stone led his adventurous array. Swiftly moving fins took the sturgeon to waters where nature had been more merciful.

The roaring surf lines of the southern shore washed vast flat stretches of sand that were bleak and sterile, for no living green relieved the monotonous wilds.

A few Indians had been driven by warfare into this dreary land. Their wigwams were scattered along the coast, where they eked out a precarious existence from the spoil of the waters.

When the sturgeon came their lives were quickened with new energy. With their bark canoes and stone spears they found many victims among the tired fish. A wrinkled prophet, who had communed with the gods of his people, in a dream, had foretold the sending of a luminous stone, by a sturgeon, that would mark the beginning of an era of prosperity and happiness for his tribe. There was rejoicing when the lustre was seen among the waves. In the belief that the promised gift of the manitous had come, and the prophecy was fulfilled, the big fish was pursued with eagerness and finally captured. The long-awaited prize was carried in triumph to the lodge of the chief. The red men gathered in solemn council, and honors were heaped upon the aged seer whose vision had become true. After long deliberation, Flying Fawn, the loveliest maiden of the tribe, was appointed keeper of the stone. The lithe and beautiful barbarian child of nature clasped it to her budding breast, and departed into the wastes. With an invocation to her gods for its protection, she hid their precious gift far beyond the reach of prying eyes.

The winds carried myriads of flying grains to the chosen spot. They came in thin veils and little spirals over the barrens, and gathered, with many sweeps and swirls, into the mound that rose over the resting place of the stone. The army of the silent sands had become its guardian, for nevermore was its hiding place known.

The winds and the years sculptured the shifting masses into strange and

bewildering forms. Trees, grasses, and flowers grew, and the hilltops were crowned with perennial garlands. The green sanctuaries were filled with melody. The forests teemed with game and the red men were in a land of plenty.

The Country of the Dunes had come into being. Somewhere deep in its bosom shines the Dream Jewel. Like "The Great Carbuncle," its fervid splendor beams from a fount unknown. Its iridescence flashes from the distant dunes at sunset. It is in the twilight afterglows, on the sapphire waters of the lake on summer days, and in the fairylands that are pictured in the pools. It glorifies dull winter landscapes with skies of infinite hues, and glances from twisted trunks of ancient pines on hills that defy the storms. It pulsates in star reflections that haunt the margins of wet sands, and where crescent moons touch the waves that toss on night horizons. Its tinge is in the tender leaves and petals of the springtime, and in the flush of autumn's robes. We see its elusive tints through vistas in the dusk, and in the purple mystery that fills the shadowy places, for the Dream Jewel is Beauty, and they who know not its holy light must walk in darkness.

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ECOLOGY ON ROLLINS ISLAND

by Varley Lang

_Man's every resource was being stripped
to feed the millions on Earth ... but George
was a throwback, and a poacher, and his
punishment had to fit the crime...._

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There's a library in a small town near Charles Neck on Murdock Sound. It's so run down and useless that a lot of old books still hang around on the shelves, the big kind with stiff backs and all kinds of fancy little stars or small, curly designs to show the end of one section and the beginning of another. Very quaint. After the WFI took over the Sound in our remote area, I didn't have much to do in the day time,

so I used to walk down the road to town and get a handful of these stiff backs once in a while. From reading them I got the notion I'm a one man resistance movement, which is pitiful and foolish, and, I gather, always has been a seedy, run-down sort of thing, a backward state of mind and feelings. That's me, alright: backward. I tried to be forward, but it made me hard to live with; and since I live mostly with myself, I had to quit. Still, I knew I couldn't get away with backwardness, and that sooner or later the WFI would slap me down, squash this bussing insect, and get on with its work again as usual.

* * * * *

Sure enough, one bleak November morning, when I was half through a couple of eggs and a cup of coffee, I heard the throb of a motor. I walked down to the end of my wharf and looked skyward. I was pretty sure they wouldn't come by land, because most of the secondary roads were in bad shape; and they wouldn't travel by water, because that took too much gas and time. In fact, the WFI never wasted anything. They couldn't afford to. Everything went for food, its growth, collection, and processing. The big freighters, some of them, had atomic piles, but that power was impossibly clumsy and expensive for smaller boats. So they came by air in the usual inspection helicopter. The pilot dropped her in the cove right alongside the wharf and made fast. Three men stepped onto the planks. They had the wheat sheaf insignia of the WFI on their overcoat arms and caps, and they looked cold and bored. A small sea sucked at the pilings and the helicopter rose and fell, grating against the wharf. I looked at the pilot and said, "Better put your chafing gear out if you intend staying a while." We all watched while the pilot put a few kapoks at the tight spots. Then he looked at a notebook and said, "You George Arthur Henry?"

I said, "Call me George."

This inspector was the usual type: tired from long hours, bored from doing nothing on a weary round of food inspections. He hunched his shoulders against the wind.

I said, "It's warmer inside."

They followed me into the kitchen of the house. All three of them started to sit down, then stopped, and walked over to the table in perfect step. They looked at the cold remains of my breakfast eggs. The WFI inspector shoved his hat up and said, "Eggs." The others nodded, wordless with wonder. Then the inspector said, "Chickens?"

"Where," I said, "do you think I got the eggs?"

The little man alongside the inspector came to life. In three dextrous movements he had glasses on, a notebook in his hand, and stylus poised.

"What do you feed them?" he inquired eagerly.

"Seeds," I said, "insects, chopped up garter snakes, mussels, ground up oyster shells. You boys have all the grain."

There was an excited light in the little man's eyes. He hurried out to a broken down shed to examine the chickens.

That left two of them. The inspector continued to gaze at the remains on the plate in a dreamy way. The other man straightened his big shoulders, looked at me, and said, jerking his thumb toward the shed, "Mr. Carter's an ecologist. He just came along for the trip. He's on his way to the Government Experimental Farm over at Murdock. I'm a government sociologist. I was sent here to have a talk with you. My name is Ranson."

"Sure. Sit down. I guess I'm licked, but there's no use making a rumpus about it."

I turned to the inspector whose eyes were still caught in the egg plate. I said, "Ever taste them?"

"Once," he said, in a far away voice. I went to the cupboard and came back with a paper bag full of eggs and put it in his hands. He held them as if someone had just given him the wheat sheaf badge of merit.

"I won't be needing these after our little talk, I expect. Take them home to the kiddies."

He smiled, looked at the sociologists, who grinned back and nodded. The inspector walked very carefully out of the back door and down to the wharf to stow his eggs in the helicopter.

Ranson shifted in his chair. He said, "That was very nice of you, Mr. Henry."

"George," I said.

"Against the law, of course." There was a smile around his eyes. "Are

you against the law, George?"

"Yes. No use bluffing. You know the story. All the waters and everything in them are WFI. All the land and everything on it. I don't like packaged food. I like real food. I don't like my oysters, crabs, clams, fish minced up and blended with chick weed, cereals, yeast, algae, plankton, and flavored to taste a little like steak. And plenty of others feel the same. I have a market."

"An illegal market."

"Yes," I said. "By God, if you had told my father, before I was born, that the oysters he tonged could not be eaten as oysters, he'd have laughed in your face. And if you had told him he wouldn't even be allowed to tong them, he'd have cussed you good and proper!"

"People have to be fed. The only way we can do it is to combine the total food resources of the world, process and package them, and do it as efficiently as possible. That means absolute control of _all_ food sources and their harvesting. You could work for WFI, George. It would be important work."

"I know. It's so important nothing else gets done. Have you seen the roads around here? Half the bridges are down across Charles Neck and Walter Hook. You can't get gas. You can't get telephones, and if you happen to have one, it doesn't work half the time. And the busses don't run any more. And--"

Ranson held up his hand. "It's an emergency, George. You have to realize that. It's been building up for a long time, long before your father worked the oyster beds in Murdock Sound."

"There's another thing," I said. "Before you fellows closed the Sound, I was independent. I had my own boat and I made my own way. Now you put your WFI scoops in the Sound and the whole job is done in a month or two. And who are the watermen? A couple of clerks to every scoop who turn a valve every once in a while and draw their packaged food, clothing, and entertainment once a week. Do you call that a job? Why, those food clerks couldn't even lift a pair of thirty foot rakes, let alone tong with them."

"We get more oysters, George, and in less time, and we do it scientifically."

Ranson tapped his notebook with the stylus and he looked out of the kitchen window. He was giving me time to cool off. He'd been kind and patient when he didn't have to be either. With his job he had no time to sit and reason with a one man resistance movement. He had no time for anything but food, and organizing society to keep it grubbing incessantly for food, and, at the same time, to keep society as orderly and contented as possible. I was not orderly and I was not contented. But I was just one man, not society. I cooled off.

I said, "Look, Ranson. It's like this. I know you're right. I've had a look around, and I've thought about it some. The figures are with you: too many men and not enough food. Only thing is, even from your point of view, I'm not fit for WFI. I have to be on my own. There ought to be somewhere, someplace for a man, instead of a food clerk---" I trailed off unhappily.

* * * * *

"I'm afraid you have no alternative, George. You are a criminal in the eyes of the WFI. Either you will work for WFI or you will be punished." He paused.

"I won't work for them."

Carter, the ecologist, burst in at the door, slammed his gloves down in the middle of the kitchen table. "Ranson, you never saw anything like it. Fifty in the flock, two roosters, all in fine shape. Lice of course, some bone malformation in the legs. But healthy."

He began to ask me dozens of questions, but Ranson interrupted.

"I need your help, Carter, and time's wasting. Among other depredations, George Henry, here, has been robbing government oyster beds, trapping government crabs, netting government fish, presumably at night. I needn't add that he has a ready and lucrative market. In effect, he refuses to cease his depredations, he refuses to join the WFI, and he is generally uncooperative."

Carter said, "uncooperative," in an absent way. He dragged his mind away from a flock of fifty fowl living in a most unusual ecology, narrowed his eyes, and asked a shrewd question.

"How did he get there?"

"What?"

"To the beds."

Ranson said, "Where did you get the gas, George?"

"I didn't. Took the engine out, put in a well and center-board, shipped a mast, and rigged her for sail. She's tucked away up in Marshwater Creek."

They were astounded. Nobody had sailed pleasure craft for a generation: no leisure and no money for such a waste of time; and sail craft were too inefficient for food collecting.

"My God, George," Ranson said, "you're a living anachronism!"

Carter nodded. He adjusted his glasses, looked at me, and said quietly, "He is also an able man."

"His abilities will be largely wasted in a Penal Food Processing Plant," Ranson said grimly.

"Oh, I agree, I agree." Carter nodded his head emphatically. "The wrong environment entirely. No scope. No initiative." He gave me a glance of understanding that warmed me right through and also had the unfortunate effect of taking some of the starch out of me. I had been prepared for hostility and indifference. I stood up and walked to the sink for a glass of water I didn't want.

"Now," Carter said, talking to Ranson, "you take the way he walks. Notice how he swings his arms, with his hands a little forward, as if ready to grip, and the tilt of his head, alert, watchful. You don't see that often. Different attitude, different environment."

Ranson sighed. "Get down to business."

"Yes. There's always this terrible lack of manpower, machine power, everything, all swallowed up in food. And besides, the men can't stand those bird stations. Too lonely. Can't meet an emergency. Four of them died on Rollins Island three winters ago when the power plant failed. Just sat there and froze. Terrible thing. Had to install emergency two-way radios; need the equipment elsewhere."

"They died of loneliness, if you ask me," Ranson said.

Carter nodded. "And no gas available for boat inspection. Helicopter too wasteful for a single station. Put George out there with one or two others. Could you sail out? Seaworthy? Big enough?"

I said yes.

"Good. Food processing all done by machines. Just feed birds in. Take up to half the colony of young birds when bred, half the old ones when coming to nest. Regular inspection of tern colonies by sail, your boat. Helicopter lands June twenty, small freighter in July to load processed birds in Rollins Harbor. Just the thing."

He took off his glasses to show that the problem had been solved.

"Look," Ranson said. "I don't have anything against George personally. I want him to be useful and contented. If he can't be contented, then at least I want him to be useful, instead of wasteful. Robbing government food resources is a grave offense, but even that doesn't justify putting him down in the middle of a pile of excrement where no ordinary man can breathe for more than a few minutes without stifling."

"Healthy," Carter said. "Healthy. It does stink. That's one reason we have such trouble keeping the stations manned."

"Boys," I said. "What is this pile of dung I'm supposed to sit on? And what birds? And why?"

Carter explained. In the desperate search for food, the sea birds were now being subjected to an annual harvest. From various nesting places along all the ocean coasts in the world, birds were harvested, to say nothing of their eggs, in large numbers. It was simply a matter of catching and killing the birds, gathering their eggs, and feeding the processing hoppers with same. These foods were later shipped to Food Processing Plants to be added to other harvests and packaged for consumption. In some cases, more specialized processing was necessary, as with the fulmars on Rollins Island. The fulmars were much prized because their alimentary system contained an especially stinking oil rich in fat and vitamin A. In their case, no eggs were collected, since they bred only once in a season, and the birds were separately processed to retrieve the oil.

Literally millions of sea birds and their eggs were cropped yearly from nesting sites on the east coast of North America alone. It was a

regular and assured source of food on an enormous scale the world over. The thousands of tons of excrement were also gathered every five years to be used in food processing and in agriculture. It was the policy of the WFI to waste nothing and to use everything.

The cropping of the young birds took place in the spring and early summer, depending on the species. The adult birds were trapped by various devices when they returned to their nests. Over-cropping was carefully avoided to insure a steady annual production.

"If it's the island or a Penal Food Plant, I'll take the island. I'm a waterman, not a bird collector. At least I'll get a chance to use the boat once in a while."

Both the WFI men looked relieved. Then Ranson put a question.

"Do you know of anyone else around here who might be fitted for such work? I'm not asking you to inform. I know there's been a good deal of discontent in this Sound region, which is one reason why I'm here. The island may be a solution for other misfits as well."

I thought it over. "The Jackson boys aren't very happy. They were the best men with drift nets this Sound has ever seen. Now they sit on stools all day long and watch a row of bottles pass in front of lights. Once in a while they lift a bottle out of the line and put it aside. They get very drunk every night on some stuff they make out of berries and dandelions from the marsh."

Ranson sighed. Carter again passed a warming look of complete understanding, and nodded encouragement.

"Then there's Pete Younger. He was a trapper before WFI closed the muskrat areas. He turns a valve several hundred times a day in the Small Fish Processor. He oils his traps and talks to himself. He may be too far gone. I think he is."

"Anyone else?"

"Others. But the WFI has a bight on them for good, I guess. They were men, once."

"Are the Jackson men married?"

I smiled. "No. We're dying out."

Carter chuckled.

* * * * *

It was a twenty-five mile sail to Rollins Island. The Jackson boys and I loaded the boat with clothing mostly. Food was stored on the island. I took along four pairs of oyster rakes, I didn't have the heart to leave them behind. And Bill and Joy took a huge ball of linen twine, ropes, corks, rings, all the makings for a drift net.

Unexpectedly, Carter showed up at the last minute by helicopter to see us off. He jumped up on the wharf smiling.

"About those chickens," he said, "they're condemned stock of course. Better take them along. And keep an eye on them. Want to know how they make out in a new environment."

Then he took me aside and handed me a small book.

"Lot of information in this. Written by a small animal ecologist. Read it. Read it carefully. Think about it. Read it again, and think some more. Got that?"

I said, "Sure. I'll read it." I had the notion he was trying to get something over without actually coming out with it flat, so I listened carefully.

He paused for a while, wiping his glasses and pursing his lips.

"That island's not right for fulmars and gannets. Wrong environment. Never have multiplied as they should. Whole thing should be concentrated north. Plenty of cliff sites north. None here. Won't do. Terns, yes. Fulmars and gannets, no. Trouble is, WFI is tenacious. Stupidly so. It works, they say. I tell them it works badly. It's going to take a lot to move them: total failure of a colony or two.

"You're intelligent, George. Put two and two together. Wish you luck."

He shook my hand quickly and jumped into the helicopter. Bill and Joy had to call me twice before I could come out of a trance of bewildered speculation. In a daze I helped the boys load our last piece of equipment: a huge barrel of salt they had pilfered from the local Food Plant.

* * * * *

The island is big, about five by fifteen miles, and it must have been a fine piece of land. It still was, even though mucked everywhere with white-to-greenish bird dung. There were steep hills on the mainland side, marshes to seaward, and in the middle natural meadowland broken by woods containing pine, and some beech and maple. We moored in a small but fairly deep harbor at a wharf for loading foods. Our barracks stood just off the wharf. In addition to all the necessities, there was a two-way radio, marked "Use in emergency only", and a handbook with information on approximate numbers of birds to be taken, locations of nesting sites, and so on. Equipment, including snares and nets, was stored in an equipment room. And there was a storeroom containing packaged foods, no freezing or cooling necessary for preservation.

Behind the barracks stood a warehouse for storing processed birds, and a shop with the processors themselves. Everything looked orderly and efficient. A small plant supplied us with light and heat and power for the machines.

We arrived in November. By December, the first sea birds began to return to their nesting sites, a few at a time. Soon we were so busy snagging them as they came to land that we had little time for anything but work and sleep. Even so, Bill took the time to salt several dozens of gannets and fulmars for future eating, and he was looking forward to the eggs.

Spring and early summer soon rolled around, and we were collecting young birds, the nestlings. So it went.

I can't say any of us liked the work. For one thing we all sickened of the endless slaughter. For another, the stench and dirt were overwhelming. The island should have been a fine place for living. There were sheltered spots for houses, a small harbor, woodlots, meadows for cattle and pigs, some bottom land for food crops, the sea for fish--a fine location; but it was ruined by birds. It was a slimy, stinking hell.

The birds flew everywhere in huge flocks, especially in the morning when the gannets and fulmars came back from fishing at sea. Excrement fell from the sky like a stinking sleet. We couldn't get away from the smell or the smell away from us. It was in our clothing, hair, under our fingernails. No watermen ever washed so often or so thoroughly as

we did, but the stink remained. We lost weight and appetite steadily, for the packaged food tasted of excrement soon after it was opened, or seemed to, which is just as bad.

However, by the end of June most of the birds had left, and we had our helicopter inspection. The same man who was fascinated by the cold remains of a couple of eggs in my kitchen was on this route, and we cooked three or four of our chickens. His enormous appetite sharpened ours, and we had a feast. He was almost tearfully grateful. By July, the freighter had put in, loaded, and left. For the first time in many months, we were unoccupied.

Bill and Joy immediately set about knitting a large drift net. They were happily excited at the prospect of gilling large numbers of government fish. As for me, I sat down to read a book on small animal ecology.

I read that book through three times. I kept at it night and day, and it was the hardest work I've ever done, because I wasn't reading just to pass the time. There was a message in that book, I was sure of it, a message from Carter, a man I liked and trusted.

By the time I began to get a glimmering of an idea as to what Carter's message was, the boys had their net knitted and hung. I went back to the book to find out what to do about this idea, and the boys sailed out to drift the net. I waited for them in a sweat of impatience. They came back at dawn the next day with a boat load of food fish. I met them at the wharf.

"Bill," I said, "what are you going to do with that load of fish?"

Bill looked at the fish. He said with slow and tremendous satisfaction, "I aim to eat them fish, George Henry."

"Bill," I said, "not even you can eat all those fish. I've got a scheme. Save back some of the fish, sure. Let Joy smoke a few even. But take the rest into Murdock tonight and sell them to Hornsby. He used to buy my oysters. He'll buy your fish."

"What for?" Bill asked.

"Get some bootleg gin," I said.

"That makes sense. What else?"

"Rats," I said. "I want rats. Buy some traps or get Pete Younger to make some. Not muskrats. Barn rats. As many as you can catch."

"Fish," Bill said. "Fish for rats. Boy, the birds has got you."

He gave in after a while, more to keep me good natured than for any other reason, that and the gin. He came back with two dozen live, healthy specimens, and watched with an open mouth as I let them loose.

* * * * *

The months passed, and I was worried. To drive the problem from my head, I took the boat out and surveyed the shallow waters off the island. I found something. I found a bed of oysters in broken rock, a bed not marked on WFI charts, because you could see it hadn't been worked for a long time. Later, I located clam beds on the marshy side of the island. The damn place was a paradise, or might be, once those birds were cut down, but I couldn't eliminate them by sheer slaughter because of the WFI.

There didn't seem to be many rats around. December came and all the filthy, stinking work with it, and still no rats. Once in a while, eggs would be missing from occupied nests, and that was all. Gulls could have gotten those. We toiled through stinking February, foul March, odiferous April, and evil-smelling May. Still no rats.

I sent Bill back to the mainland for more; and by September, rats were everywhere. Bill looked at me from his bunk one night and said, "I hope you're satisfied."

I was more than that. I was terrified. They absolutely swarmed. It was impossible to walk from the barracks to the boat at mid-day without having to kick rats off the path. They consumed most of the non-metallic gear in the boat, including the sail. So far, they hadn't gnawed a way into our barracks store room, or we'd have literally starved to death.

"Boys," I said, "just sit tight. Wait till December. These rats are the best friends you ever had. They're going to make this island livable. No more stink and stench."

"What," said Bill, "are you going to do with the rats when the birds are gone?"

Joy merely moaned.

"We'll kill them."

"If they don't get us first," Bill said.

It was an awesome and bloody slaughter. The fulmars and gannets, most of the gulls, some of the terns, were either wiped out or harried off the island in a single season. And the island became a heaving, moving, revolting mass of rats, and nothing but rats. They attacked us on sight, from sheer hunger. Not a blade of grass grew anywhere on the island, and rats are not grass eaters as an ordinary thing. There was one hopeful sign. They were beginning to eat each other.

Day after day we were caged in our barracks. The constant squealing and scratching under the barracks was bad enough. What made us desperate was the fact that they had gnawed a way into the store room and most of the packaged food was gone. We still had some smoked fish hung on the rafters, and a few salted fulmars in the barrel, but that was all. It was then that we remembered the two-way radio, marked "Use in emergency only". Bill said, after weighing all the evidence coolly and carefully, that this here, in his opinion, was an emergency.

I got WFI mainland and finally persuaded them to put me in touch with Carter, Bird Stations Ecologist. I told him we were having a little trouble with the genus *Rattus*, and would he, for God's sake, do something about it, quick. I can still hear him laughing. It was a while before he could speak at all.

"Keep them at bay, general. I'll be over early tomorrow morning."

I don't believe any men have ever been so happy to see Carter as we were.

"They'll balance," he said. "Starvation will do its work. I've brought along a couple of pairs of barn owls. They'll help a lot. I see you read that ecology book. Good job. Station virtually wiped out. I'm sending supplies over in a week's time. Anybody wants to know, you're supposed to be helping extend and restore the tern and gull colonies. Wouldn't be a bad idea to try a few other animal experiments. Milder, though. Smaller scale. Send canvas for a sail too."

He was gone before we could answer. The small freighter put in July

fifteenth. She had no cargo of processed birds to take back, of course. The captain detailed a few men to unload our supplies, and we helped them eagerly. There were six calves and heifers, two cows and a bull, five pigs, one boar and two sows, several dozen hens and a rooster. Best of all, there was a big case containing seeds: corn, barley, oats, seed potatoes, melons, beets, kale, dozens of others. A plow and two draught horses, mare and stallion. Several pounds of rat poison. A hand forge and several tons of coke. Iron. A hundred pounds of linen twine for nets, as well as ropes of all sizes. Canvas. Tools of all kinds. A big medical kit.

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In a year's time, we had prospered. No richer land, due to the bird droppings, was ever farmed. And the sandier areas could be depended upon for melons and other crops demanding a lighter, drier, and not so rich soil. Not only that, but we were five, now, instead of three. The Jackson boys had lured a couple of husky girls to the island in the boat. The boys claimed the women fell in love with them. I think they fell in love with the island.

This fast work on the part of the Jacksons seemed a little rash to me. I was still not at all sure we'd be allowed to remain and enjoy the work we had done. Several times, I was tempted to use the radio again, but decided to wait. I'm glad now I did.

* * * * *

In August, a little more than a year after his last visit, Carter set his helicopter down at the wharf again.

After lunch in the barracks of baked fish, fresh milk, potatoes, salad, and melons, he pushed back his chair and said, "I suppose you've been wondering."

"We'd like to know," I said.

He nodded. "The mainland's going to pieces. So is the whole world. It isn't just food. We can still produce that. Remember what you said about the bad roads, bad telephones? You put your finger on it. So much manpower, machinery, energy, material is used up in getting food and processing it and distributing it, there isn't enough for other things. A tenth of the world's population and a quarter of its total power resources go into processing plankton alone. We are literally

eating ourselves to death. Utilities and services are breaking down rapidly. No new dwellings of any kind have been built for ten years or more. Oil is short, cement, iron, steel, coal, plastics, wiring, radios, telephones, everything is in short supply and getting shorter. Transport is staggering to a halt."

He paused, took off his glasses, and twirled them by one side piece.

"Many of us saw it coming. A few decided to do something. We thought there should be undisturbed nuclei, a few able people with ample food supplies. You are one such center. There are others at various bird stations along the coast. You'll be joined shortly by a few more people, young men and women, among them a trained nurse, a doctor, a skilled carpenter, so on."

Bill cleared his throat.

"What you said, I guess it was all around me, only I never seen it, not to put together. Just one thing. The manager at the Food Plant, he used to stop and kid me about all the fish I'd stole from the government in my time. He was abraggin' about how WFI had newer and better ways of gettin' things done, always newer and better every year. How come they couldn't keep caught up?"

"Bill, those new techniques that manager talked about were old stuff a hundred, two hundred years ago. The applications are new, some of them, but the basic ideas are old.

"The World Food Institute drew off all the scientific, inventive brains of the world, and put them to chasing food. No time for basic research, basic development; just time for tinkering and retinkering old ideas. Been no new basic idea for a couple of centuries. Too much need for immediate, practical results. The well is dry, and it won't be filled again with a reservoir of new, big ideas, not in our time. Been living off the past; and the present has caught up with us."

* * * * *

Before Carter left the island to visit the other stations, I had a chance to have a talk with him.

"Was that sociologist, Ranson, in on this?"

"No. We had to be careful. Still have to be. Just a few of us. That's

why the loss of the bird colonies here had to seem natural, or at least a natural accident. And I had to keep clear of it. You can see that."

"Carter, what happens on the mainland when things break up?"

"Won't be pretty. Bad. Very bad."

"For example?"

"You read the ecology book. What happens when a species multiplies beyond its ability to feed itself?"

* * * * *

A dozen new Rollins Islanders showed up a few at a time in Carter's helicopter. We've been working and waiting a long time now, waiting for Carter to come back. For over a year now, our boat has made no crossing to the mainland. Last night, over twenty-five miles of sea in clear weather, we saw the sky lit by a great fire.

I haven't forgotten those rats. I dream about them, tearing one another with bloody fangs.

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CROCODILIA

The Project Gutenberg eBook of Water Reptiles of the Past and Present, by Samuel Wendell Williston

The order of reptiles to which the name Crocodilia is technically applied comprises less than twenty-five living species, popularly known as crocodiles, alligators, caimans, and gavials. They are often of great size, ugly and repulsive in appearance, cruel and vicious in habit, wholly carnivorous, and denizens, almost exclusively, of fresh-water lakes or rivers in tropical and subtropical regions; a few only venture into the sea near the shores. They are all excellent and powerful swimmers, but are by no means exclusively aquatic in habit, many of them spending a large part of the time on the shores; and they invariably seek the land for the deposition and hatching of their eggs. In size they are the largest of living reptiles, some of the existing species reaching a length of twenty-five feet, while some extinct species were probably fully twice that length.

The geological history of the crocodiles is a very ancient one, reaching back at least as far as the early Jurassic and probably to

the Triassic. The culmination of the order, at least so far as size, variety, and numbers are concerned, was doubtless before the close of the Mesozoic. The early crocodiles, however, were of a more generalized structure in some respects, though specialized in others, because of which naturalists in the past have usually divided the order into three or four chief subdivisions, or suborders, two of which, the Mesosuchia and the Thalattosuchia, became extinct before or during Cretaceous time. The third suborder, the Parasuchia of many textbooks, has now been unanimously separated by paleontologists from the Crocodilia as an independent order. The fourth suborder of the textbooks, the Eusuchia, a word meaning *_true_* crocodiles, appeared in geological history, so far as we yet know, shortly before the extinction of the Mesosuchia, and is best known from the forms now living, all of which belong to it. Although the modern crocodiles can hardly be called, as a group, purely aquatic reptiles, we shall find it of interest, because of their intimate relation to the older and more strictly marine forms, to speak of them somewhat in detail.

MODERN CROCODILES, EUSUCHIA

The crocodiles of the present—and we use the word in the technical sense of Crocodilia—because of their general resemblance to the lizards, or true “saurians,” were classed with them by the older naturalists, whence comes the popular name alligator, a corruption of the Spanish *_el lagarto_*, or “the lizard,” given to some of the South American forms by early explorers. But this resemblance is a superficial one only, as was early recognized by comparative anatomists. The crocodiles, indeed, are only remotely related to the lizards.

The head or cranium is flattened and broad, the facial part or snout sometimes greatly elongated and slender, and the external nostrils are always situated at the front end. The bones of the upper surface of the cranium and face have many pit-like depressions. The neck is short and stout, and but little movable. The body is somewhat depressed and flattened, not cylindrical and slender, as in the more typical water reptiles. The tail is much elongated and compressed, forming a powerful means of propulsion in swimming, its breadth being increased by a vertical row of horny plates above. The limbs are of the ordinary elongated type—ambulatory rather than swimming legs—and are not of much use for propelling the body in the water; the front legs indeed are usually held close to the body while the animal is swimming. The toes, however, are partially connected by webs, to a slight extent only in

the alligators and crocodiles, but much more so in the long-snouted gavials. The feet have five toes in front and four behind; and the loss of the fifth toe can only be ascribed to terrestrial habits. The body is covered more or less with horny scutes or scales, beneath which are several rows of thickened, pitted, bony plates on the dorsal side, and sometimes also on the under side, forming a more or less extensive bony armor. The eyes have movable lids, as in most lizards, and the ear-opening is small.

But the external appearance of these reptiles is not sufficient to distinguish them widely from other groups, and we must resort to the internal structure, especially that of the skeleton, for the more essential differential characters. The most crucial of these, the one which more than any other determines their relationships, consists in the position and shape of the bone with which the lower jaw articulates, the quadrate bone, so characteristic of reptiles. As in the plesiosaurian and ichthyosaurian skulls, it is firmly united with the adjoining bones, not articulating freely with them, as in the lizards and snakes. But this fixed relation of the bones is very unlike that of the plesiosaurs, ichthyosaurs, and turtles, in that it is held in place by two bony bars or arches, the upper extending forward to unite with the bones at the back part of the orbit, the lower, with the hind extremity of the upper jaw. The lower jaws are rigidly united in front, sometimes for a long distance; they have, almost always, a hole or opening through the hinder part, known in but few other reptiles. The bones of the palate are all firmly united, forming a nearly complete roof, very unlike the condition in the mosasaurs and lizards. The palate also is very peculiar in the development of a plate of bone below the nasal chambers, forming a complete bony canal on each side through which the respiratory air passes far back to the internal opening of the nostrils above the pharynx, and not, as in other reptiles—save the immediate ancestors of the mammals—entering the mouth at the front end. This peculiar arrangement of the air-passages, so like that of ourselves, has much to do with the water habits of the crocodiles, as we shall see.

The teeth are conical in shape, and are always restricted to the edges of the jaws, above and below. They are inserted deeply and firmly in sockets, and are replaced frequently by new ones growing beneath them, pushing the older ones out as their usefulness becomes impaired by injury or by use. In some species there are as many as thirty teeth in each side of the jaws, above and below, although the broad-headed kinds have a smaller number.

The neck is short, as has been stated, but it always includes in living forms nine vertebrae, a number probably slightly in excess of that of their terrestrial forbears. By the peculiar mode of attachment of the short "hatchet-shaped" ribs, much lateral movement of the neck is prohibited, nor is any very great vertical movement possible. The vertebrae of the whole column, save the atlas, the second sacral, and the first caudal—which is a very remarkable anomaly—are concave in front and convex behind, agreeing in this respect with those of all other living reptiles, save the turtles, the tuatera, and some lizards. The ribs of the neck have their two heads attached, one to the body of the vertebra, the other to the arch, but those of the dorsal region, though double-headed, have both become attached to the transverse projection of the arch, a seemingly trivial character, but one which immediately distinguishes all crocodiles from all other water reptiles, and from all terrestrial reptiles, indeed, save the Parasuchia, Pterosauria, and Dinosauria. The pelvis is firmly attached to the spinal column by two sacral vertebrae.

The collar-bones, or clavicles, are wanting in crocodiles; there is a slender interclavicle; and the shoulder-blade and coracoid are well developed (Fig. 102). The bones of the pelvis are loosely united with each other as they are in most reptiles (Fig. 104). The pubes, the anterior bones below, unlike those of all other reptiles, do not help to form the acetabulum or socket for the articulation of the thigh bone, nor do they articulate with each other. This single character sharply distinguishes a crocodile from all other reptiles, living or extinct, and is almost the only character that separates the order from the dinosaurs, aside from the peculiar structure of the nasal passages in the skull. On the under side of the body, connected with the front end of the pubes, there are seven or eight pairs of abdominal ribs, corresponding to the plastron of the turtles and similar to those of the ichthyosaurs and plesiosaurs. The mosasaurs have no such ribs.

Furthermore, the crocodiles differ from all other living reptiles in having a four-chambered heart, like that of birds and mammals, that is, a heart with two auricles and two ventricles. This more perfect structure of the circulatory organs does not, however, insure at all times a complete separation of the pure or arterial blood from the impure or venous blood, since the blood may be more or less intermixed outside of the heart by a connection between the venous and the arterial systems. Whether these imperfectly developed organs, so suggestive of a higher and more perfect mode of respiration, are the vestiges of what were once among some reptiles functional structures, or whether they are rudiments of a higher organization, developing

independently in these creatures, cannot be positively determined, but it seems very probable that, far back in geological times, some reptiles, especially the pterodactyls and dinosaurs, had their respiratory and circulatory systems more like those of the birds and mammals of today. Unfortunately, however, if such was the case, we may never be able to prove it, although proof would not be impossible; stranger things than fossil hearts have been found by paleontologists!

The stomach, moreover, in the crocodiles is fashioned somewhat after that of the birds, with an imperfect division into crop and gizzard. Some crocodiles of today have the habit of swallowing hard pebbles, as do many birds. There is an old myth that the crocodile of the Nile swallows a pebble on each of its birthdays, thus giving reliable information as to its age by the number found in its gizzard at its death! And this habit has been suggested for some of the most ancient crocodiles, the teleosaurs, by the recurring presence of siliceous pebbles found with the remains of their skeletons. And we have seen this pebble-swallowing habit was also characteristic of the plesiosaurs, with whose remains "stomach-stones," or gastroliths, as they have been called, are often found.

All of these various characters of the skeleton and fleshy parts are pretty conclusive evidence that the crocodiles, ugly creatures that they are, today enjoy the highest rank among cold-blooded animals. They are perhaps in some respects of not so high a type of reptiles as were some of the extinct reptiles, but that they have survived so long, so many millions of years, is pretty good evidence of endurance, to say the least.

Living crocodiles belong to three distinct groups or families: the true crocodiles and alligators; the long-snouted crocodiles or Borneo gavials; and the true gavials of India. Members of the first of these families are really only subaquatic, or amphibious in habit; they move about on land with entire freedom, and often seek their food there. Certain marked aquatic characters they do possess, in the skull and tail, as we shall see. They are indigenous to southern China, India, Africa, Madagascar, the southern part of the United States, Central America, and the northern part of South America. The members of this family are distinguished by the more or less broad and flat head, the possession of comparatively few teeth of large size, and by having the toes less completely webbed. The crocodiles proper differ from the caimans and alligators especially in the arrangement of the teeth. During later geological times, that is, during early Tertiary times, the geographical range of the Crocodylidae was much more extended

than it is at present, the remains of many often very large species, being found in the lake deposits of the northwestern parts of the United States, Great Britain, Germany, France, etc. Yet earlier, in the late Cretaceous rocks of the United States, in Texas, and Wyoming especially, there have been found rather scanty remains of a gigantic crocodile which must have been nearly fifty feet in length when living.

The second family, the Tomistomidae, or long-snouted crocodiles, comprises but two living species, both restricted at the present time to Borneo. These crocodiles have a moderately slender snout, because of which they are sometimes called gavials, though it is not nearly so slender as that of the true Gangetic gaval. This family is probably older than either of the other living ones, and is the only one known with certainty to have lived during much of the Cretaceous times, several species of considerable size having been found in New Jersey and Europe. Their feet are better webbed than are those of the true crocodiles and alligators, the front feet partly, the hind feet wholly so. In general structure they seem to be the most primitive of the living Crocodilia, and may have been the ancestors of all modern forms.

The third family, the Gavialidae, also comprises but two living species, both restricted in habitat to the rivers of India. Of these the famed gaval of the Ganges is the better known and the more highly specialized. The skull of this species has an exceedingly long and slender snout; the teeth are numerous, small, and slender; and the feet are more fully webbed than are those of other members of the order. In habits the gavials are more distinctly aquatic than are the crocodiles and alligators. They feed almost exclusively upon small fishes, for the seizure and retention of which their small and sharply pointed teeth are admirably adapted. The hind feet are relatively long, a character that will be better understood when comparison is made with those of the *Thalattosuchia*. Although attaining a large size, fully twenty-five feet in length, they are comparatively harmless animals, never attacking human beings or other large animals, as do some of the crocodiles proper. The gavials have lived a long time in the Indian regions, the Gangetic gaval itself having been found in deposits of Pleiocene age, perhaps the oldest known of all living species of air-breathing vertebrates. Some of the extinct gavials of the same region attained a length of nearly or quite fifty feet, possibly the longest, if not the largest, of all swimming reptiles of ancient or modern times. Extinct gavials have been reported from South America, but are not yet fully known.

While the fish-eating gavials swallow their prey whole, the crocodiles,

caimans, and alligators prey upon all living animals that come within their reach, whether large or small, and they will often leave the water to seize their intended victims, such as pigs, sheep, birds, or even human beings. Their teeth, as has been already stated, are much larger, longer, and more irregular in size than those of the gavials. Their victims are often drawn under the water and drowned, the peculiar posterior position of the internal nostrils permitting the animals to breathe with the mouth and to firmly hold their prey under water, while the extremity of the snout and the external nostrils are above the surface.

As the firm, unyielding bony palate, the fixed position and articulation of the lower jaws, and their rigid attachment to each other in front do not permit creatures of large size to enter the gullet whole, the crocodiles and alligators must tear their food to pieces, which they do by quick, strong jerks from side to side, aided by the powerful tail; or they may twist off a limb or some other part of their victims by a rapid rotation of the whole body, two assisting in this operation, rotating in opposite directions.

Living crocodiles lay from twenty to sixty eggs, according to the species; these eggs are sometimes the size of a goose egg, and are covered with a hard shell. They are laid either in a deep excavation in the sand and covered over by the parent; or under leaves and straw. The female remains on guard until the eggs are hatched, of which she is apprized, it is said, by a peculiar noise uttered by the partly imprisoned young. She thereupon reopens the nest, and guides her liberated infants to the water, where she leaves them to their fate. Whether this remarkable habit is one that has been acquired in recent times or not is uncertain, but because it has been observed in a number of unrelated forms, it is probable that the instinct is of long inheritance, and may account for certain peculiarities of structure in some of the ancient members of the order. Doubtless the habit arose because of the unprotected places in which the eggs are necessarily laid on the shores and beaches, and because the eggs are comparatively so few in number. The sea-turtles likewise lay their eggs in hollows scooped out of the sand of the beaches, but the parents give no further care to their eggs, nor to their newly hatched offspring, a neglect which is compensated for by the much larger number of eggs they lay, because of which the chances are much greater that a few will survive the more numerous vicissitudes to which the eggs and young turtles are exposed.

ANCIENT CROCODILES, MESOSUCHIA

The name Mesosuchia, meaning “middle crocodiles,” by which the ancient members of the Crocodilia have generally been known, was given by Huxley in the belief that they were intermediate between the “true” or modern crocodiles and an ancient group which he united with the order under the name “Parasuchia.” A fuller and better knowledge of the members of this last group has proved very conclusively that they are really less allied to the crocodiles than are some other orders of reptiles, the dinosaurs for instance, and should be properly classed by themselves as a distinct order. And, more recently, it has also become quite apparent that the old crocodiles should not be separated so widely from the modern ones as Huxley proposed; that the differences distinguishing them from the recent members of the order are really not of more than family importance. We thus have left but two chief divisions of the Crocodilia, the Eusuchia and Thalattosuchia; and the latter group even, by some authors, perhaps rightly, are included under the true crocodiles as a family only.

These older crocodiles, the Mesosuchia of Huxley, comprise a considerable number of extinct forms which lived as far back as the early part of the Jurassic, and continued nearly to, if not actually into, Cenozoic time, that is, to the Eocene. They differ from all living forms, chiefly in having, not concavo-convex but biconcave backbones, that is, the more primitive vertebrae with which all reptiles began. Nor was the internal opening of the nasal passages so far back in the mouth as in the later forms. In other respects they did not differ very greatly from some of those now living. All the earliest kinds that we know of—the teleosaurs—had a long, slender snout, resembling very much that of the modern gavials. And they were, for the most part, incased in a more complete bony armor, on both the dorsal and the ventral sides; and the front legs were smaller than those of the gavials even. The resemblance of the living teleosaurs to the modern gavials must have been very great, although the heavier bony armor indicates a less exclusively aquatic life. They probably lived more in the shallow waters of the seas near the shores.

Near the close of the Jurassic appeared for the first time, so far as we now know, broad-headed mesosuchian crocodiles, forms having less numerous and stronger teeth, and resembling closely modern alligators. It has been believed that these broad-headed kinds were of later origin than the more slender-nosed teleosaurs, but a moment's consideration will make it evident how improbable such an evolution must be. The crocodiles must have descended from strictly terrestrial reptiles, and

no terrestrial reptiles have a slender nose. That they should have acquired a slender face in adaptation to water habits and then returned to the more primitive land type with a broad face and less strictly aquatic habits is contrary to all our experience in paleontology. From this it is altogether probable that broad-faced crocodiles of later times must have been the descendants of broad-faced kinds that were in existence during all the Jurassic times, but of which we as yet have no knowledge. These broad-faced Jurassic crocodiles were, for the most part, small creatures, much smaller than the teleosaurs even, and smaller than any species of crocodiles now living. Their remains are known only from fresh-water or shore deposits, and are, for the most part, associated with those of land and fresh-water animals. About the time of their first known appearance in geological history, the small mammals and birds had also become more or less abundant, and it was suggested by Owen that these land animals had something to do with the development of the ancient amphibious crocodiles. Perhaps this was the case with respect to their greater abundance and development, and with certain peculiarities of their structure, but that the gavial-like teleosaurs should have come back to the land and reverted to a more primitive form seems quite improbable.

During Cretaceous times, especially in America, numerous forms of these old mesosuchian crocodiles were doubtless in existence, both slender-nosed and broad-nosed, and some of them must have been of considerable size, though none known was as large as some of the late crocodiles. This type, with biconcave vertebrae, continued to live on, in both North and South America, to the latter part of Cretaceous times, and it is even possible that some continued on into the Tertiary. But long before the close of the Cretaceous, the modern kind appeared, those with concavo-convex vertebrae, and more posterior internal nostrils. The earliest are known from New Jersey (*Thoracosaurus*, *Holops*), so like the Borneo gavials of today that they are properly classified in the same family, the Tomistomidae or Gavialidae. If all the later, procoelian type, that is, those with concavo-convex vertebrae, originated from a single form when the amphicoelian or mesosuchian type became extinct, Huxley's classification into the Mesosuchia and Eusuchia would perhaps be proper, but we have much reason to suppose that the change in the kinds of vertebra and in the position of the nostrils was only incidental, and may have occurred in more than one line of descent, that is, it may have occurred in the broad-headed kinds of the Jurassic to the broad-headed crocodiles of today, as also in the gavial-like forms of the Cretaceous to the gavials of the present. And this is the reason why naturalists no longer recognize the classification of Huxley,

which, partly perhaps because of the prestige of his name, has so long been accepted in our chief works on natural history.

MARINE CROCODILES, THALATTOSUCHIA

While the ancient crocodiles of which we have spoken resembled the modern ones so closely in form of body and probably in habits, there were certain others of the old Jurassic seas which departed so widely both in structure and in habits, from their associates that they are by some authors given a place wholly by themselves as a distinct group. This has been called by Professor Fraas the Thalattosuchia, a word meaning "sea-crocodiles." They were a very early side-branch from the great genealogical tree of the Crocodilia, a branch which departed so widely from their associates in adapting themselves to a peculiar and aberrant mode of existence that they cannot be considered as typical crocodiles, although so closely related to them in other respects that there cannot be the least doubt regarding their ancestry. None of the crocodiles which we have considered, whether ancient or modern, can truthfully be called purely aquatic. They never ceased to use their limbs for locomotion on land, more or less of the time, or for the support of the body; and many of them have subsisted, in part at least, on land animals. How easy it may have been for some of them to become almost wholly emancipated from land habits we may easily conjecture. The gavials, as we have seen, are more at home in the water than upon land; their food is chiefly found in the water; but, so long as their habits restrict them chiefly to fresh-water, or to the vicinity of the shores, their limbs continue to be used as much for crawling as for swimming. Were the gavials to be driven out to sea by the stress of fresh-water conditions or attracted thereto by a greater abundance of more easily obtainable or better food, so far from land that they no longer would have much use for their legs for the support or propulsion of their bodies, in the course of time they would doubtless change to a more purely aquatic type. And in that change there would be material modifications of their structure: their limbs would become better adapted to movements in the water; the skin would become smoother, and the bony and horny scales would be lost, since they would be not only useless in the water, but actually detrimental to the well-being of the animals; and the tail would develop into a more powerful organ of propulsion, as a means of increasing their speed in obtaining food or in escaping their enemies, such as the sharks. In fact, we can only imagine that in the transformation precisely those modifications would occur which we actually find in these old sea-crocodiles, the Thalattosuchia. And they are of especial interest

to us here because nowhere do we find a better example of Nature in the act of transforming a terrestrial or subterrestrial animal into a truly aquatic one.

The group comprises only a few forms, so far as known. All were of modest size among extinct reptiles, from ten to twenty feet in length, and all are from the Upper Jurassic deposits of Europe. They did not exist very long, probably because they found it impossible to discard old habits and old structures entirely and become absolutely emancipated from the land; their breeding habits possibly were too deeply impressed into their structure readily to change, as did those of other sea-reptiles. Some of their remarkable aquatic adaptations have long been known, but only within a dozen years has our knowledge of them become at all complete. Three or four genera have been described, but only a few forms are well known, of which *Geosaurus* may be taken as most typical. To this we shall confine our descriptions.

The skull of *Geosaurus* is rather small in comparison with the length of the body, smaller proportionally than in any living crocodile, but not much smaller than that of the teleosaurs. The snout is long and slender, much like that of the teleosaurs and gavials, but the bones of the whole upper surface are quite smooth, not roughened and pitted like those of modern forms. The skull of *Dakosaurus*, another genus of thalattosuchians, is much less elongate than that of *Geosaurus*, but has the other characteristics of *Geosaurus*. The eyes are provided with a stout ring of sclerotic bones, with a pupillary opening of less than one inch. We have seen that all other strictly aquatic reptiles have similar eye bones, but no other crocodiles have them. The internal openings of the nostrils are large and long, but they are not situated far back, as in the modern crocodiles, not even so far back as in the early teleosaurs. They had no need of the peculiar breathing apparatus of the amphibious crocodiles, since all their prey must have been water-breathing creatures. Their eyes were directed laterally, not more or less upward, as in their nearest relatives. Nearly all other crocodiles have an opening through the hind end of the lower jaw, but the thalattosuchians did not. The teeth were about as numerous as in the modern gavials, but they projected freely only a short distance above the gums in life, and they were very slender and sharply pointed, excellently well adapted for catching smooth and slippery fishes. Their vertebrae, like those of all other reptiles of their time, were biconcave. Those of the neck resembled those of the teleosaurs, save that there were only seven, fewer than is the case with any other members of the order. In becoming adapted to their peculiar mode of life these crocodiles lost two vertebrae from the neck. All

modern crocodiles have two ribs attached to the first vertebra; the thalattosaurs had but one, another evidence of primitive characters. While the number of vertebrae in the neck was reduced, in the back it was increased to eighteen; all other crocodiles have but fifteen or sixteen. The trunk was long, another adaptation to water life. There were two firmly united vertebrae in the sacrum, as in the modern forms. The reason for the persistence of this terrestrial character we shall see later.

The tail was very long and strong, nearly as long as all the remainder of the body, and relatively much longer than in other crocodiles. It is of interest to observe that the head, neck, body, and tail had almost the same relative proportions as those of the great sea-lizards, the mosasaurs. The terminal bones of the tail are very peculiar, and very different from the corresponding bones of other crocodiles. While the spines of the tail bones along the anterior part are only moderately stout and long, and are directed obliquely backward, near the terminal part they become suddenly much broader and are directed upward, and, a little farther along, obliquely forward. The chevron bones on the under side also here become broader and longer. The end of the tail curves markedly downward to end in a slender point. It will be remembered that a similar downward curvature of the end of the tail observed in nearly all specimens of ichthyosaurs induced in Owen the belief that the animals had a fleshy terminal fin, a belief which later discoveries of the carbonized remains of the flesh confirmed. The peculiar structures observed in various specimens of these sea-crocodiles, even though no impressions or remains of the fleshy parts have been discovered, is quite conclusive evidence that these animals also had a broad, fleshy, terminal fin. No other explanation of the structure is possible.

The ribs are not at all stout and are not much curved. They are directed posteriorly in the known specimens preserved in the matrix in such a way as to indicate a slender thorax and abdomen, not the broad body of the modern crocodiles. The abdominal ribs, that is, those protecting the region on the under side of the body between the breast bone and the pelvis, are strongly developed in Geosaurus. The sternum, always present in other crocodiles, is wanting in Geosaurus. The shoulder-blades and coracoids, often changed in shape in water reptiles, are not unlike those of the amphibious crocodiles, but are smaller and flatter.

The fore limbs, to use Professor Fraas's words, "are among the most interesting of all the peculiarities of Geosaurus," and show very clearly that these animals were excellent swimmers. The humerus is

remarkably short and broad; the two bones of the forearm, the radius and ulna, are broad, rounded, or angular plates, not long bones, as in other crocodiles; the wrist bones also are broad and plate-like. The three bones of the thumb, that is of the digit which received most strongly the impact of the water in swimming, are also broad and flat. All of these bones are marvelously aquatic in type, as will be evident from a comparison of them with the corresponding bones of the ichthyosaurs and mosasaurs. The bones of the other fingers, however, were not much changed from the ordinary crocodilian form, as a further comparison of them with the fingers of a land crocodile will show. Furthermore the whole limb or paddle was very small in comparison with the hind leg, and it was attached very near to the head. The relative proportions of the front and hind limbs in the geosaurs, gavials, and alligators are instructive as showing the progressive decrease in size of the front legs from the subaquatic, through the semiaquatic, to the almost purely aquatic type. The hind legs, strangely enough, were not very different in size and structure from those of the gavials or teleosaurs. The thigh bone is long and slender, though the bones of the leg and ankle are somewhat shortened and flattened, as are also those of the first toe. There were no claws on the hind feet, a distinctly aquatic adaptation, and the toes were certainly webbed. The pelvis, while not especially stout, is of good size, and was firmly attached to the sacrum.

Perhaps all these characters may best be summed up in the words of Professor Fraas, as translated:

We recognize in Geosaurus an unusually slenderly built crocodile, in appearance very different from all true crocodiles. The smooth, rounded skull, with its greatly elongated and slender snout, and the deep-lying, small eyes, reminds one most of the ichthyosaurs. The skull merges into the slender, elongated trunk without a visible neck, and the body was provided neither above nor below with horny or bony armor, but was, probably, as in the whales, covered with a smooth, soft skin. The anterior extremities, attached far forward, are developed as paddles, and served rather as organs of equilibration than as a means of propulsion, which was the function of the elongated hind legs and the extraordinarily strong and powerful tail, which supported at its end a large fin. The entire impression given of the animal is that of an excellent swimmer, with all the peculiar aquatic adaptations. In the skeleton, however, all the characters of the original crocodiles are preserved.

Most remarkable are the laterally placed eyes, protected by the stout sclerotic bones, and the overhanging bones of the orbits. So, too, the large temporal openings of the skull, doubtless due to the absence of the bony plates in the integument, give to the animal a strangely abnormal appearance for a crocodile.

We have observed that all the truly aquatic air-breathing animals, save the plesiosaurs, have either lost the hind legs or else have them greatly reduced in size, and the disproportionately large size of these members in _Geosaurus_ seems inexplicable. But an explanation is not, I think, hard to find. In the adaptation to water life the first to become modified for the control of the body are the front legs. The hind legs never have any really important use when the tail is a powerful propeller. The hind legs of the geosaurs are still essentially legs and not paddles, and they were doubtless used either occasionally for propulsion on land, or perhaps for pushing the body about on the bottom of shallow waters. And the presence of a well-developed ventral armor of bony ribs possibly also indicates more or less of the terrestrial crawling habit. As soon as the hind legs cease to be used for crawling they take on only a feeble use for the equilibration of the body, and speedily become small, until finally they disappear. That the hind legs of these creatures were of some use in the water is certain, because of the modifications in their structure, and especially because of the loss of the claws; but that they were of important use as propellers is hardly probable. We may therefore infer that the thalattosuchians, while distinctively sea-reptiles, had not entirely lost their land habits. Moreover, it is highly probable that their egg-laying habits, which would hardly change with a greater adaptation to water life, compelled the animals recurrently to visit the shores. To have finally lost their hind legs they must have become viviparous in habit, since it seems to be impossible for any true air-breathers to be hatched in water. Perhaps this insurmountable habit was the final cause of their extinction in competition with the truly viviparous aquatic flesh-eaters. The thalattosuchians had but a brief existence in geological history, during the latter part of the Jurassic period only, so far as certainly known, nor did they become widely dispersed over the earth; they are known from Europe, possibly from Brazil.

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HALF PAST ALLIGATOR

By Donald Colvin

Illustrated by BARTH

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It takes sportsmanship to make a ball team ...
and foul play to get a backward race civilized!

Bill Bradley shooed away the group of Quxas that had surged over the first-base line. With broad grins on their flat, piebald faces, they moved away--in the wrong direction, of course--and squatted in a smiling semicircle around Pat Reed, who was playing third. This was bad, because Reed was a fifty-fifty player: It was an even chance whether he got the ball or the ball got him. One of the half-domesticated thrags broke loose and cantered across the outfield with its peculiar five-legged gait. In the hubbub, Ray Bush stole second. Nobody seemed to notice.

Sighing heavily, Bill returned to the mound and whiplashed in a fast one, tight across the letters. The hitter got only a small piece of it; a pop fly sauntered toward left field. Judging it to a nicety, Gust Mustas came racing in, evaded a tethered thrag, leaped a hole some Quxa had dug and forgotten, and made a shoestring catch, retiring the side. The Quxas cheered deliriously.

Bill trotted off the mound. For a moment, the thrill of the game held him. This was the way things should be: The feel of smoothly flowing muscles, the thudding sound of horsehide hitting a leather glove, the weight of a bat in your hands in your first ball game after clambering over and scrabbling in an unexplored planet for fourteen months.

Then he caught sight of Candace Mathews, walking among the pneuma-huts that served as the outpost camp for the expedition. Gloom enveloped him again, surrounding him like a dank fog.

* * * * *

For fourteen long months, Bill had feasted on the memory of Candy Mathews, on his recollection of her turquoise eyes and cascading brown hair, on the remembrance of her soft lips on his last night under the four moons of Vensor III.

Today she had arrived with the seventy-odd men and women who comprised the appraisal unit, the final group of the planet's explorers. He had looked forward like a schoolboy to her coming. And, like a schoolboy, he had suffered black despair when his dreams were shattered.

For the Candy Mathews who got off the shuttlebug at Camp Outpost was not the Candy Mathews who had said soft words on Vensor III. She was, instead, a self-assured young woman, somehow harder, who felt only an indifferent tolerance toward a tall young man named Bill Bradley, and an all-consuming, hero-worshipping infatuation for a newcomer, a dapper walking brain, Vance Montgomery, one of the council's smart boys, with the title of planet evaluator.

"He's simply wonderful," she had said. And the joy of life had gone out of Bill Bradley.

The appraisal group brought in athletic equipment and Bill's men spontaneously declared a holiday, their first on the planet. Baseball was the order of the afternoon and they shanghaied a not unwilling Bill to pitch. He should, he knew, be laying out reports for Montgomery to study. He did not particularly want to be with Montgomery.

Bill sat on the xetal log that served as a bench.

One Quxa was bent over, examining first base. He made a colorful sight. The first baseman slapped him jovially on the loin cloth to move him.

The owner of the thrag caught up to it and was struggling manfully to lead it away. The five-legged beast defied his efforts, rearing and dragging him. A dozen Quxas stood nearby. Their sympathies were obviously with their fellow-Quxa, but they made no move to help him.

Reed was on the bench next to Bill. He had come in with the appraisal group.

"Your vivid friends," he said, cocking a thumb at the Quxas, "don't

appear too bright."

"They're smart enough," said Bill. "Almost as intelligent as we are. It's just that they've never risen above a herd culture."

"Look," said Reed. "I'm a silviculturist. Give me a hunk of wood and I can tell how long it took to grow, what it's good for, where it can be raised and how much board and profit can be made out of it. But this kind of talk throws me. Try another wave-length."

"Socially, they're like the seals or penguins back on Earth. They like to gather in groups. The things they can do individually, they do well. But they don't know how to help each other. That's beyond them."

"Don't understand the meaning of cooperation?"

"The word isn't even in their language. I've seen forty of them standing around, fretting and stewing, while the horals killed off one of their fellows."

"What are horals?"

"The other dominant life-form here. Nasty brutes, like big upright ants with tentacles. Stand about as high as my chest. Most malignant things I've seen. One Quxa can handle any horal, maybe even two or three. But the horals hunt in packs. Good-by Quxa."

"Killing them off, are they?"

"This is the last big concentration the Quxas have left. In another hundred years, there'll be no more Quxas."

* * * * *

They looked again at the natives. The Quxas were something to see--human in form, although somewhat shorter than Earthmen; their skins were blotched and dashed with patches of vivid colors. Antiquarians talked of their resemblance to the ancient circus clowns, a likeness furthered by their broad, flat faces and habitual grins.

"Sort of hate to see them disappear," Bill said glumly. "They're happy, good-natured creatures. In their whole race, I know only one who's mean. We've done our best to help them. But if they won't cooperate even in a matter of life and death, what incentive can you offer them?"

An elbow dug into him.

"Up to the platter, dream boy," said Gust Mustas. "A hit means two runs."

Selecting a bat, Bill made his way to the plate. In the middle distance, Vance Montgomery emerged from a hut. Candy went to him eagerly, put a hand on his arm. A deep rage engulfed Bill.

The first pitch was a curve that failed to break. As it came fatly over the plate, Bill swung angrily. The ball rocketed up and away, past the infield, over the head of the desperately running left-fielder and dropped toward a sure home run.

Then a curious thing happened. One of the Quxas darted away from the gabbling group along the foul line, his short legs churning over the uneven ground. As the ball sank, he dove, plucked it out of the air with one broad hand, turned a somersault and came up with it, grinning. It was an impossible catch and the Earthmen joined the Quxas in applause. Still clinging to the ball, the Quxa made little bobbing bows of acknowledgment.

"Throw it in!" shouted Bill. The Quxa stood motionless. "Throw it in, Adlaa!" Bill urged. He went through a throwing motion.

The Quxa nodded comprehension. He went into a violent wind-up. His left foot came up, his upper body went back, his right arm snapped in an arc. The ball flew from his hand, straight and fast.

In the wrong direction, of course.

The pack of Quxas pelted after it, shouting, picked it up and threw again. To his surprise, Bill found himself pounding after them, bawling fruitless pleas, aware that he looked foolish, but, in his rage, not caring. He closed in on them on the fifth throw and his fingertips touched the ball. He succeeded only in deflecting it. There was a dull _thunk_ and the game was over. The ball had struck Vance Montgomery, planet evaluator, squarely in the left eye.

Three things were said then to Bill Bradley.

One was by Montgomery as he handed back the ball. "I was not aware, Bradley, that the job of camp leader entailed joining the rowdyism of

the native races."

One was by Candy Mathews, hopping with anger. "You're a barbarian, Bill Bradley. Monty might have been badly hurt."

The third was by a clot of Quxas, crowding eagerly. "Play ball! Billbrad, more play ball!"

To the first two, Bill did not reply. To the Quxas, he said one word, "Nuts!" and dolefully followed Montgomery into the headquarters hut.

* * * * *

In spite of his natural prejudice against Montgomery, Bill was forced into a reluctant admiration for the way the man worked.

Montgomery's task was to recommend whether the planet should be marked for immediate colonization, placed on a reserve list for future expansion, or be left strictly alone as unworthy of occupancy. He tore through Bill's reports like a small child through a bag of jellybeans. His questions, if pompous, were pointed.

Within twenty-four hours, ready to leave for the main camp, he called a conference.

He stood before the group, as dapper as a man can be with a rainbow bruise under one eye, complacently listening to the resonance of his own voice. Beside him, Candy nodded worshipful agreement. Bill grumped in a corner.

For a full forty-five minutes, Montgomery outlined additional data he wanted gathered. His voice was faintly chiding, implying by its tone that anybody but a dolt would have obtained the information long ago.

"And now," he said, "we come to the question of the humanoid denizens of this planet--the so-called Quxas." He fingered his black eye. "Many persons might conclude that the Quxas are not worth saving; and in themselves, they are not. However, my preliminary conclusions--based, unfortunately, on insufficient data--lead me to believe that this planet will be used for colonization in about five hundred years. It would be very convenient then to have a dominant life-form friendly to the galactic humans and capable of being integrated with the colonists. Some method of preserving the Quxas must therefore be worked out. In this, the advance group has failed lamentably."

He paused, glanced around triumphantly.

"How do I propose to achieve this? By a historical method. What do nations do when they are in peril? They call upon a single man, place themselves under him and let him lead them out. When the ancient western civilization was in its greatest danger after the fall of Rome, the people gathered around the strong men, made them kings and dukes and earls, and were saved from barbarism.

"I shall do the same for the Quxas. The Quxas shall have a king."

His eyes sought out Bill.

"My acquaintance here has been short. I must rely on advice. Bradley, whom would you recommend as king of the Quxas?"

"Well," said Bill slowly, "Moahlo is the most intelligent. He's good-natured and kindly. He has a lot of artistic ability. Some of his carvings are being taken back for the Galactic Folk Museum."

"An artist!" said Montgomery in disgust. "Well, let's have a look at him."

* * * * *

Moahlo was finishing a figurine near one of the meandering paths that the Quxas had worn by habit, not design. A bemused group of natives looked on admiringly.

Down the path came Ratakka, the biggest of the Quxas, his shoulders proudly back, his face set in the truculent scowl. Bill knew and disliked him, and apprehensively felt sure the peaceful scene would be destroyed. Alone of an amiable, tolerant race, Ratakka was perpetually ill-tempered, the rankling product of Lord knew what alien genetic accident or trauma.

Ratakka found his path obstructed by the carving. Callously, he brought his foot down on the delicate figurine, crushing it to splinters. Moahlo sprang up in gentle protest. Ratakka gave him the back of a meaty hand that knocked him off his feet. Two spectators indicated disapproval. Ratakka smashed their heads together and strode on.

"To save a culture, Bradley," said Montgomery, who had watched the

brutal display with admiration, "you need strength, not delicacy or feeling. That man shall be king of the Quxas."

He ran after Ratakka.

The members of the outpost staff looked at Bill in dismay. He shrugged sadly and walked out of the headquarters hut. At the doorway, Adlaa was waiting for him with the same old plea.

"Play ball?" he begged. "More play ball, Billbrad?"

In his despondent mood, Bill did not care.

"All right. I'll throw the ball to you and you throw it back to me."

"Quxas not do that."

"It's just as much fun to throw the ball in one direction as in any other direction," Bill explained patiently. "Unless you throw it back, forget it--no play ball."

Adlaa thought seriously. "Hunky dokey. Want play ball."

They were tossing it back and forth in the middle of a cheering group when a half-track passed, taking Montgomery, Candy and Ratakka to the main camp. The look that the girl gave Bill was disdainful.

"There's a gaggle of natives outside in assorted shades," said Pat Reed the next day. "They want to play ball. Moahlo's at their head. He carved a bat."

"Tell them to beat it. We're busy."

"Let's give them some fun while we can. They won't enjoy life much after King Rat gets back here."

"That's the truth," Bill agreed. "All right."

* * * * *

"I wish your painted idiots would get over their baseball mania," complained Rudy Peters, the mineralogist, two days later. "Look me over carefully, will you, Bill? I think my throwing arm just dropped off."

"They're nutty about it, all right," Bill Bradley said. "Too bad it couldn't have been about something with some economic value."

"Economic value, the man wants. Okay, I'll talk economic value to you. Bet you fifty units I can make a better ball team out of these freaks than you can."

"Well, make it thirty."

"You're on, sucker. I've lined up the sweetest shortstop that ever spit in a glove ..."

"Here's your thirty," said Rudy Peters a week after. "How was I to know that shortstop wouldn't throw the ball to anyone except the center-fielder?"

"Team play's the stuff, lad," said Bill Bradley. "Stress team play. Twenty-five, twenty-seven, twenty-nine, thirty. Exactly right. Another lesson at the same price?"

He was refused, but never on an exploration had Bill Bradley had so much fun. And never, he reminded himself grimly, had he got so little work done. The Quxas were neglecting their skimpy food plots in their eagerness to play. They were getting lean. Finally, with reluctance, Bill called a temporary halt to baseball.

"Billbrad say no baseball until work done," said Moahlo sadly to Adlaa. "Sometimes Billbrad talk like southpaw pitcher."

Adlaa was trying to cultivate his food plot with the help of a thrag. The beast was of independent mind. It dragged Adlaa in eccentric ovals, in defiance of agricultural needs.

"Adlaa want finish work, play baseball," the Quxa commented. "Thrag no play baseball, say nuts to work. Adlaa be old like Old Hoss Radbourne before work done."

Moahlo contemplated. "Adlaa have trouble his thrag. Moahlo have trouble his. Moahlo help Adlaa his thrag and Adlaa help Moahlo his. Get work done more faster."

Adlaa dismissed the revolutionary thought. "Quxas not do."

"We play baseball run down play," argued Moahlo. "Play together. You

throw ball me. I throw ball you. Yippee. Man out."

"Same team. Old pals. Want sing team song?"

"Want play team with thrag."

Adlaa considered the matter in this new light. "Like ball game," he said at last in amazement.

"Sure. You, me be us together. Make thrag look like busher."

They both took hold of the thrag. Unable to resist their combined strengths, the beast submitted docilely. They began to work.

* * * * *

Glancing out from his labor in the headquarters pneuma-hut, Bill saw the incident in happy surprise. Perhaps, after all, his stay here might produce something to help the culture that Montgomery would introduce upon his return. He had no doubt of Montgomery's success.

Neither, for that matter, had Montgomery. At the main camp, things were going swimmingly.

The camp lay on the very fringe of the Quxa territory, but, by an arduous hunt, Ratakka had captured eight wandering Quxas to whom he immediately set about teaching the duties of subjects. His method was simple--the Quxa followed his orders, which he obtained from Montgomery, or the Quxa was knocked down. If he still refused, he was knocked down again. Within three weeks, Ratakka had them doing things no Quxas ever had done before. They performed them reluctantly and sullenly, but they did them.

Seeing the result, but not the means, Candy was enthusiastic.

"They're working together!" she cried. "Oh, Monty, what will the Quxas do to reward you?"

"Oh, they'll probably make a culture god of me," said Montgomery, managing to look modest. "Like the Greeks did to that Martian, Proma Ss Thaa, who taught them the use of fire."

As time went on, though, the girl began to have doubts.

"But they're doing everything for Ratakka," she protested. "As far as they're concerned themselves, they're more wretched than before."

"That's the way feudal cultures are built, my dear," Montgomery assured her. "The king gives them law and a fighting leader. In return, the subjects take care of his bodily comfort."

"But they look so unhappy!"

"In saving an inferior race, we cannot be concerned too much about the happiness of a few miserable members. Perhaps in three hundred years or so, they can afford happiness."

And finally an incident happened to complete her disillusionment.

One of Ratakka's morose subjects managed to slip the shackles with which he was bound at night and make a bolt for freedom. The king pursued him relentlessly, brought him back and then beat him, coldly and cruelly, slugging and gouging and kicking.

Ashen-faced, Candy moved to interfere; Montgomery restrained her.

"We're saving a race," he said. "You can't make an omelet without breaking a few eggs."

Candy turned and ran sobbing to her quarters, unable to dispel the memory of the writhing body on the ground.

* * * * *

The next day was the day to move equipment. It was a policy of the expeditions to leave their wornout machines for the most friendly of the native races, who could dismantle them and use the parts. The equipment not worth toting back to Earth was to be taken to the advance camp, where the Quxa center was. Montgomery also planned that day to take Ratakka to his kingdom.

A few minutes ahead of the motorcade, Candy slipped out, got into a battered half-track and started driving the eighty miles to the advance camp. For the first twenty-five miles, she told herself that her eagerness was because it was a nice day and she wanted to get out of camp.

For the next twenty-five miles, she called herself a liar.

For the third twenty-five miles she gave herself up unashamedly to thinking about Bill Bradley: his smile, his gentleness, the awkward grace of his lean body. Not a man to set a planet on fire--but how pleasant and restful to have around!

She wondered if he would forgive the way she had acted. Somehow she was sure he would.

The narrow vehicular trail ran through a grove of fernlike trees. It's just over the rise, Candy thought, just over the rise and down into the saucer, where Bill is waiting....

The half-track struck a rock, lurched, threw a tread and went off the road, out of control.

That did not matter especially, for the Quxas could use the material very well where it was. Candy went forward briskly afoot. A fallen branch brushed her ankle. Unheeding, she kicked it away. She began to reconstruct Bill, feature by feature: the way his hair swirled on his forehead; his eyebrows, arched and regular; his eyes, wide, deep-seated, with inner pools of merriment; his nose, straight and rather ...

Another branch caught her. She lifted her foot to free it. It did not come free. Another tentacle moved around her, pinioning her right arm to her side. She whirled in terror and found herself in the grip of the horrors.

* * * * *

There were a dozen of the horrors, their antenna ears erect, mandibles open. They exuded an acid odor, a sign of hunger. Candy screamed. She fought to reach her pistol, strapped to her right hip. More tentacles stopped her. She screamed and screamed again, throwing her body to shake off the grip, trying to kick with her feet.

There was a movement in the road at the top of the rise. For a moment, elation surged in Candy, almost stifling her. Perhaps some expedition member had heard her, was hurrying to her rescue. Then she saw that the newcomers were Quxas. Hope vanished, leaving her limp and hollow. To be killed by these horrors was bad enough, but to be killed in the presence of a group of piebald morons, who would stand and watch and moan, but not lift a hand ...

In her agitation, she did not notice that the Quxas were nine in number and wore baseball caps. They drew short clubs, shaped like bats.

"Kill the umpire!" they shouted, hatred born of diamond conflicts in their cry. "Kill the umpire!" they yelled and charged.

* * * * *

In military formation, they clubbed their way through their enemies, battering and smashing until Candy was free, with a dozen dying horals on the ground, their tentacles contracting and writhing. The Quxa leader made his bobbing bow to her.

"How do," he said politely. "We dip them in calcimine vat, you bet. We hang them out like wash. Now we give team yell."

The Quxas put their arms around each other's shoulders. In unison, they chanted:

"Hoe tomata; hoe potata
Half past alligata,
Bum, bum, bulligata,
Chickala dah!
Pussycats! Pussycats!
Rah! Rah! Rah!"

"Pussycats," the leader explained to Candy, "are honored animal on planet where Billbrad is head cheese."

"I'll bet you play baseball nicely," Candy said.

Woe broke forth on nine broad faces.

"Misfortunately not," confessed the captain. "Thirty-three teams in Quxa town. Pussycats in thirty-third place." He brightened. "Go ivory hunt now. Catch nine new Quxas. Teach 'em baseball. Then maybe we beat 'em and not be in cellar any more."

Together, the team bobbed politely to Candy and trotted down the road.

Happily, Candy went up the rise, then stopped in astonishment, looking at Quxa town.

Gone was the straggling, haphazard settlement, with the flimsy huts and untended starvation patches where individual Quxas tried to raise their own food. Instead, building sites were laid out in straight, broad rows, and Quxas were working, three and four in a group, raising substantial homes of timber. Others were surrounding the settlement with a wall of brambles, impenetrable to horals. Teams of men, two to a thrag, were plowing, preparing large fields for tillage. And down the side of the settlement, affectionately tended, ran a line of baseball fields.

Just off the road, a Quxa squatted, baseball cap on his head, watching a crude sun dial.

"Nice day for game," he greeted Candy.

* * * * *

Speechless with surprise, the girl made a dazed questioning gesture toward the improvements.

"Billbrad do it," the Quxa informed her. "He tell us how. Work one by one, he say, work all time to fill belly, maybe fill horal belly instead. Work all by all, do more quick. Have time in afternoon. Batter up! Sock it, boy! Wing it home, he sliding!"

The sun's shadow touched a peg.

"Five minute!" bawled the Quxa.

The laborers quit work, put away their tools. The farmers herded their thrags into a strongly constructed corral. The natives gathered in knots at the settlement edge and looked longingly at the baseball fields.

"Yestday I fool Billbrad," confided the Quxa. "I hide ball, catch him off second. Billbrad get all red face and say--"

"Never mind what Bill said," Candy interjected hastily.

The shadow touched another peg.

"Play ball!" the Quxa yelled. "Play ball! Play ball! Play ball!"

He sprang up, produced a baseball glove and spat into it reverently.

"I go play now. You come see. Get scorecard, know players."

He looked at Candy hopefully.

"Specially me," he added.

Out of the moil of Quxas came the lank form of Bill Bradley. He spied the girl, whooped and came running to her. For a few moments they talked at once, in an incoherent and ecstatic jumble. Then Candy, catching control of herself, cited in admiration the change in the Quxa village.

"And you've done all this!" she concluded.

"I didn't do anything!" Bill protested. "They like to play baseball and this sort of happened. We're getting representative government into action now. Each team elects a captain and the captains are the town council. Tonight they're going to vote on naming the settlement Brooklyn."

"You know," said Candy, "I'll bet they'll make you a culture god."

* * * * *

The tanned face of Bill Bradley took on the rose hue of a blush.

"Well, Moahlo carved a statue and they've put it in front of league headquarters--that's their city hall," he admitted uncomfortably. "It doesn't look much like me. I've got six arms because they wanted me batting, pitching and catching a ball all at the same time."

Candy slipped a hand into his.

"Is there a place around here," she asked in a small tone, "where a culture god can take a girl and--well, talk to her?"

"Is there!" said Bill. "You just come with me ..."

A heavy object bumped into him. He whirled at the touch.

"Oh! Hi, Ratakka," Bill said in a flat voice.

Montgomery's king had returned to his subjects. He was alone--his

captives having escaped off the ride over--and he was in vile temper. Glaring evilly, he motioned at the baseball players. He was recalling an advice of Montgomery: "Whatever your subjects like to do most, do it better than they can. In that way, you will get their respect and find it easier to take over."

"What that fool doings-on?" snarled Ratakka. "Ratakka do, too."

Bill's already sagging spirits sank again. With Ratakka's strength and reflexes, the great brute undoubtedly would become the star of stars, gathering admirers to himself and destroying all the pleasant prospects now so happily started. Still, it was Bill's duty to give him every chance ...

"I'll see what team has an opening, Ratakka. Perhaps you'd better bat seventh for a few days. Then you can move to the clean-up spot."

The giant stopped him. "Ratakka not ordinary Quxa; Ratakka a king. Ratakka not play like those serfs. Want special job."

A wild thought struck Bill. On the playing fields were more than two hundred Quxas, most of them with a justified and carefully nurtured dislike for the surly slab of muscle before him. In the old days, they could do nothing individually against him.

But the Quxas had learned to fight as a team. If he could only give them the shadow of an excuse, trap Ratakka into rousing their joint anger, take advantage of the prejudices of their new-found love for baseball, then Ratakka would get the reckoning that he deserved, the days of his supremacy would be over, the threat of his tyranny would be removed from a happy race.

* * * * *

Bill grinned broadly. "Sure thing, old pal," he said.

He took off his own baseball cap and put it backward on Ratakka's head. He signaled for someone to bring over a mask and chest protector.

"There's only one of these at each playing field," Bill explained. "In a way, he's boss of the game. Are you sure you want to do it? Sometimes the players argue with you."

"Anyone argue with Ratakka," the giant said, raising a huge fist,

"Ratakka knock 'em down. Ratakka a king, boss of game."

"Okay, boy, you asked for it," Bill said.

He thrust a whiskbroom into Ratakka's hand.

"You can be umpire," said Bill Bradley.

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THE GLOW-WORM

The Project Gutenberg eBook of Fabre's Book of Insects, by Jean-Henri Fabre

I

HIS SURGICAL INSTRUMENT

Few insects enjoy more fame than the Glow-worm, the curious little animal who celebrates the joy of life by lighting a lantern at its tail-end. We all know it, at least by name, even if we have not seen it roaming through the grass, like a spark fallen from the full moon. The Greeks of old called it the Bright-tailed, and modern science gives it the name *Lampyrus*.

As a matter of fact the *Lampyrus* is not a worm at all, not even in general appearance. He has six short legs, which he well knows how to use, for he is a real gad-about. The male, when he is full-grown has wing-cases, like the true Beetle that he is. The female is an unattractive creature who knows nothing of the delights of flying and all her life remains in the larva, or incomplete form. Even at this stage the word "worm" is out of place. We French use the phrase "naked as a worm" to express the lack of any kind of protection. Now the *Lampyrus* is clothed, that is to say he wears an outer skin that serves as a defence; and he is, moreover, rather richly coloured. He is dark brown, with pale pink on the chest; and each segment, or division, of his body is ornamented at the edge with two spots of fairly bright red. A costume like this was never worn by a worm!

Nevertheless we will continue to call him the Glow-worm, since it is by that name that he is best known to the world.

The two most interesting peculiarities about the Glow-worm are, first, the way he secures his food, and secondly, the lantern at his tail.

A famous Frenchman, a master of the science of food, once said:

“Show me what you eat, and I will tell you what you are.”

A similar question should be addressed to every insect whose habits we propose to study; for the information supplied by food is the chief of all the documents of animal life. Well, in spite of his innocent appearance, the Glow-worm is an eater of flesh, a hunter of game; and he carries on his hunting with rare villainy. His regular prey is the Snail. This fact has long been known; but what is not so well known is his curious method of attack, of which I have seen no other example anywhere.

Before he begins to feed on his victim he gives it an anæsthetic—he makes it unconscious, as a person is made unconscious with chloroform before a surgical operation. His food, as a rule, is a certain small Snail hardly the size of a cherry, which collects in clusters during the hot weather, on the stiff stubble and other dry stalks by the roadside, and there remains motionless, in profound meditation, throughout the scorching summer days. In some such place as this I have often seen the Glow-worm feasting on his unconscious prey, which he had just paralysed on its shaky support.

But he frequents other places too. At the edge of cool, damp ditches, where the vegetation is varied, many Snails are to be found; and in such spots as these the Glow-worm can kill his victim on the ground. I can reproduce these conditions at home, and can there follow the operator's performance down to the smallest detail.

I will try to describe the strange sight. I place a little grass in a wide glass jar. In this I install a few Glow-worms and a supply of Snails of a suitable size, neither too large nor too small. One must be patient and wait, and above all keep a careful watch, for the events take place unexpectedly and do not last long.

For a moment the Glow-worm examines his prey, which, according to its habit, is completely hidden in the shell, except for the edge of the “mantle,” which projects slightly. Then the hunter draws his weapon. It is a very simple weapon, but it cannot be seen without a magnifying-glass. It consists of two mandibles, bent back into a hook, very sharp and as thin as a hair. Through the microscope one can see a slender groove running down the hook. And that is all.

The insect repeatedly taps the Snail's mantle with its instrument. It all happens with such gentleness as to suggest kisses rather than bites. As children, teasing one another, we used to talk of "tweaks" to express a slight squeeze of the finger-tips, something more like tickling than a serious pinch. Let us use that word. In conversation with animals, language loses nothing by remaining simple. The Glow-worm gives tweaks to the Snail.

He doles them out methodically, without hurrying, and takes a brief rest after each of them, as though to find out what effect has been produced. The number of tweaks is not great: half a dozen at most, which are enough to make the Snail motionless, and to rob him of all feeling. That other pinches are administered later, at the time of eating, seems very likely, but I cannot say anything for certain on that subject. The first few, however—there are never many—are enough to prevent the Snail from feeling anything, thanks to the promptitude of the Glow-worm, who, at lightning speed, darts some kind of poison into his victim by means of his grooved hooks.

There is no doubt at all that the Snail is made insensible to pain. If, when the Glow-worm has dealt some four or five of his twitches, I take away the victim and prick it with a fine needle, there is not a quiver in the wounded flesh, there is not the smallest sign of life. Moreover, I occasionally chance to see Snails attacked by the Lampyris while they are creeping along the ground, the foot slowly crawling, the tentacles swollen to their full extent. A few disordered movements betray a brief excitement on the part of the Snail, and then everything ceases: the foot no longer crawls, the front-part loses its graceful curve, the tentacles become limp and give way under their own weight, dangling feebly like a broken stick. The Snail, to all appearance, is dead.

He is not, however, really dead. I can bring him to life again. When he has been for two or three days in a condition that is neither life nor death I give him a shower-bath. In about a couple of days my prisoner, so lately injured by the Glow-worm's treachery, is restored to his usual state. He revives, he recovers movement and sensibility. He is affected by the touch of a needle; he shifts his place, crawls, puts out his tentacles, as though nothing unusual had occurred. The general torpor, a sort of deep drunkenness, has vanished outright. The dead returns to life.

Human science did not invent the art of making a person insensible to pain, which is one of the triumphs of surgery. Far back in the centuries the Glow-worm, and apparently others too, was practising it.

The surgeon makes us breathe the fumes of ether or chloroform: the insect darts forth from his fangs very tiny doses of a special poison.

When we consider the harmless and peaceful nature of the Snail it seems curious that the Glow-worm should require this remarkable talent. But I think I know the reason.

When the Snail is on the ground, creeping, or even shrunk into his shell, the attack never presents any difficulty. The shell possesses no lid and leaves the hermit's fore-part to a great extent exposed. But it very often happens that he is in a raised position, clinging to the tip of a grass-stalk, or perhaps to the smooth surface of a stone. This support to which he fastens himself serves very well as a protection; it acts as a lid, supposing that the shell fits closely on the stone or stalk. But if the least bit of the Snail be left uncovered the slender hooks of the Glow-worm can find their way in through the gap, and in a moment the victim is made unconscious, and can be eaten in comfort.

Now, a Snail perched on top of a stalk is very easily upset. The slightest struggle, the most feeble wriggle on his part, would dislodge him; he would fall to the ground, and the Glow-worm would be left without food. It is necessary for the Snail to be made instantly unconscious of pain, or he would escape; and it must be done with a touch so delicate that it does not shake him from his stalk. And that, I think, is why the Glow-worm possesses his strange surgical instrument.

II

HIS ROSETTE

The Glow-worm not only makes his victim insensible while he is poised on the side of a dry grass-stalk, but he eats him in the same dangerous position. And his preparations for his meal are by no means simple.

What is his manner of consuming it? Does he really eat, that is to say, does he divide his food into pieces, does he carve it into minute particles, which are afterwards ground by a chewing-apparatus? I think not. I never see a trace of solid nourishment on my captives' mouths. The Glow-worm does not eat in the strict sense of the word; he merely drinks. He feeds on a thin gruel, into which he transforms his prey.

Like the flesh-eating grub of the Fly, he can digest his food before he swallows it; he turns his prey into liquid before feeding on it.

This is how things happen. A Snail has been made insensible by a Glow-worm, who is nearly always alone, even when the prize is a large one like the Common Snail. Soon a number of guests hasten up—two, three, or more—and, without any quarrel with the real owner, all alike fall to. A couple of days later, if I turn the shell so that the opening is downwards, the contents flow out like soup from a saucepan. By the time the meal is finished only insignificant remains are left.

The matter is obvious. By repeated tiny bites, similar to the tweaks which we saw administered at the beginning, the flesh of the Snail is converted into a gruel on which the various guests nourish themselves each in his own way, each working at the broth by means of some special pepsine (or digestive fluid), and each taking his own mouthfuls of it. The use of this method shows that the Glow-worm's mouth must be very feebly armed, apart from the two fangs which sting the patient and inject the poison. No doubt these fangs at the same time inject some other substance which turns the solid flesh into liquid, in such a thorough way that every morsel is turned to account.

And this is done with exquisite delicacy, though sometimes in a position that is anything but steady. The Snails imprisoned in my apparatus sometimes crawl up to the top, which is closed with a glass pane. To this pane they fix themselves with a speck of the sticky substance they carry with them; but, as they are miserly in their use of this substance, the merest shake is enough to loosen the shell and send it to the bottom of the jar.

Now it is not unusual for the Glow-worm to hoist himself to the top, with the help of a certain climbing-organ that makes up for the weakness of his legs. He selects his prey, makes a careful inspection of it to find a slit, nibbles it a little, makes it insensible, and then, without delay, proceeds to prepare the gruel which he will go on eating for days on end.

When he has finished his meal the shell is found to be absolutely empty. And yet this shell, which was fixed to the glass only by the slight smear of stickiness, has not come loose, nor even shifted its position in the smallest degree. Without any protest from the hermit who has been gradually converted into broth, it has been drained dry on the very spot at which the first attack was made. These small details show us how promptly the anæsthetic bite takes effect, and how very

skilfully the Glow-worm treats his Snail.

To do all this, poised high in air on a sheet of glass or a grass-stem, the Glow-worm must have some special limb or organ to keep him from slipping. It is plain that his short clumsy legs are not enough.

Through the magnifying-glass we can see that he does indeed possess a special organ of this kind. Beneath his body, towards the tail, there is a white spot. The glass shows that this is composed of about a dozen short, fleshy little tubes, or stumpy fingers, which are sometimes gathered into a cluster, sometimes spread into a rosette. This bunch of little fingers helps the Glow-worm to stick to a smooth surface, and also to climb. If he wishes to fix himself to a pane of glass or a stalk he opens his rosette, and spreads it wide on the support, to which it clings by its own natural stickiness. And by opening and shutting alternately it helps him to creep along and to climb.

The little fingers that form this rosette are not jointed, but are able to move in all directions. Indeed they are more like tubes than fingers, for they cannot seize anything, they can only hold on by their stickiness. They are very useful, however, for they have a third purpose, besides their powers of clinging and climbing. They are used as a sponge and brush. At a moment of rest, after a meal, the Glow-worm passes and repasses this brush over his head and sides and his whole body, a performance made possible by the flexibility of his spine. This is done point by point, from one end of the body to the other, with a scrupulous care that proves the great interest he takes in the operation. At first one may wonder why he should dust and polish himself so carefully. But no doubt, by the time he has turned the Snail into gruel inside the shell and has then spent several days in eating the result of his labours, a wash and brush-up is not amiss.

III

HIS LAMP

If the Glow-worm possessed no other talent than that of chloroforming his prey by means of a few tweaks as gentle as kisses, he would be unknown to the world in general. But he also knows how to light himself like a lantern. He shines; which is an excellent manner of becoming famous.

In the case of the female Glow-worm the lighting-apparatus occupies the last three divisions of the body. On each of the first two it takes the form, on the under surface, of a wide belt of light; on the third division or segment the bright part is much smaller, and consists only of two spots, which shine through the back, and are visible both above and below the animal. From these belts and spots there comes a glorious white light, delicately tinged with blue.

The male Glow-worm carries only the smaller of these lamps, the two spots on the end segment, which are possessed by the entire tribe. These luminous spots appear upon the young grub, and continue throughout life unchanged. And they are always visible both on the upper and lower surface, whereas the two large belts peculiar to the female shine only below the body.

I have examined the shining belt under the microscope. On the skin a sort of whitewash is spread, formed of some very fine grain-like substance, which is the source of the light. Close beside it is a curious air-tube, with a short wide stem leading to a kind of bushy tuft of delicate branches. These branches spread over the sheet of shining matter, and sometimes dip into it.

It is plain to me that the brightness is produced by the breathing-organs of the Glow-worm. There are certain substances which, when mixed with air, become luminous or even burst into flame. Such substances are called combustible, and the act of their producing light or flame by mingling with the air is called oxidisation. The lamp of the Glow-worm is the result of oxidisation. The substance that looks like whitewash is the matter that is oxidised, and the air is supplied by the tube connected with the Glow-worm's breathing-organs. But as to the nature of the shining substance, no one as yet knows anything.

We are better informed as regards another question. We know that the Glow-worm has complete control of the light he carries. He can turn it up or down, or out, as he pleases.

If the flow of air through the tube be increased, the light becomes more intense: if the same air-tube, influenced by the will of the animal, stops the passage of air, the light grows fainter or even goes out.

Excitement produces an effect upon the air-tube. I am speaking now of the modest fairy-lamp, the spots on the last segment of the Glow-worm's

body. These are suddenly and almost completely put out by any kind of flurry. When I am hunting for young Glow-worms I can plainly see them glimmering on the blades of grass; but should the least false step disturb a neighbouring twig, the light goes out at once and the insect becomes invisible.

The gorgeous belts of the females, however, are very little, if at all, affected by even the most violent surprise. I fire a gun, for instance, beside a wire-gauze cage in which I am rearing a menagerie of female Glow-worms in the open air. The explosion produces no result: the illumination continues, as bright and placid as before. I take a spray, and rain down a slight shower of cold water upon the flock. Not one of my animals puts out its light; at the very most there is a brief pause in the radiance, and then only in some cases. I send a puff of smoke from my pipe into the cage. This time the pause is more marked. There are even some lamps put out, but they are soon relit. Calm returns, and the light is as bright as ever. I take some of the captives in my fingers and tease them a little. Yet the illumination is not much dimmed, if I do not press too hard with my thumb. Nothing short of very serious reasons would make the insect put out its signals altogether.

All things considered, there is not a doubt but that the Glow-worm himself manages his lighting-apparatus, extinguishing and rekindling it at will; but there is one circumstance over which the insect has no control. If I cut off a strip of the skin, showing one of the luminous belts, and place it in a glass tube, it will shine away merrily, though not quite as brilliantly as on the living body. The presence of life is unnecessary, because the luminous skin is in direct contact with the air, and the flow of oxygen through the air-tube is therefore not required. In aerated water the skin shines as brightly as in the free air, but the light is extinguished in water that has been deprived of its air by boiling. There could be no better proof that the Glow-worm's light is the effect of oxidisation.

The light is white, calm, and soft to the eyes, and suggests a spark dropped by the full moon. In spite of its splendour it is very feeble. If we move a Glow-worm along a line of print, in perfect darkness, we can easily make out the letters one by one, and even words when they are not too long; but nothing is visible beyond this very narrow zone. A lantern of this kind soon tires the reader's patience.

These brilliant creatures know nothing at all of family affection. They lay their eggs anywhere, or rather strew them at random, either on the earth or on a blade of grass. Then they pay no further attention to

them.

From start to finish the Glow-worm shines. Even the eggs are luminous, and so are the grubs. At the approach of cold weather the latter go down into the ground, but not very far. If I dig them up I find them with their little stern-lights still shining. Even below the soil they keep their lanterns bravely alight.

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GLOW WORM

By Harlan Ellison

Illustrated by WILIMCZYK

_He was the last man on Earth, all
right. But--was he still a man?_

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When the sun sank behind the blasted horizon, its glare blotted out by the twisted wreckage rising obscenely against the hills, Seligman continued to glow.

He shone with a steady off-green aura that surrounded his body, radiated from the tips of his hair, crawled from his skin, and lit his way in the darkest night. It had been with him for two years now.

Though Seligman had never been a melodramatic man, he had more than once rolled the phrase through his mind, letting it fall from his lips:
"I'm a freak."

Which was not entirely true. There was no longer anyone he might have termed "normal" for his comparison. Not only were there no more men, there was no more life of any kind. The silence was broken only by the searching wind, picking its way cautiously between the slow-rusting girders of a dead past.

Even as he said, "Freak!" his mind washed the word with two waves, almost as one: vindictiveness and a resignation inextricably bound in self-pity, hopelessness and hatred.

"_They_ were at fault!" he screamed at the tortured piles of masonry in his path.

Across the viewer of his mind, thoughts twisted nimbly, knowing the route, having traversed it often before.

Man had reached for the stars, finding them within his reach were he willing to give up his ancestral home.

Those who had wanted space more than one planet had gone, out past the Edge, into the wilderness of no return. It would take years to get There, and the Journey Back was an unthinkable one. Time had set its seal upon them: Go, if you must, but don't look behind you.

So they had gone. They had left the steam of Venus, the grit-wind of Mars, the ice of Pluto, the sun-bake of Mercury. There had been no Earthmen left in the system of Sol. Except, of course, on Earth--which had been left to madmen.

And _they_ had been too busy throwing things at each other to worry about the stars.

The men who knew no other answer stayed and fought. They were the ones who fathered the Attilas, the Genghis Khans, the Hitlers. They were the ones who pushed the buttons and launched the missiles that chased each other across the skies, fell like downed birds, exploded, blasted, cratered, chewed-out and carved-out the face of the planet. They were also the little men who had failed to resist, even as they had failed to look up at the night sky.

They were the ones who had destroyed the Earth.

Now no one was left. No man. Just Seligman. And he glowed.

"_They_ were at fault!" he screamed again, and the sound was a lost thing in the night.

* * * * *

His mind carried him back through the years to the days near the end of what had to be the Last War, because there would be no one left to fight another. He was carried back again to the sterile white rooms where the searching instruments, the prying needles, the clucking scientists, all labored over him and his group.

They were to be a last-ditch throwaway. They were the indestructible men: a new breed of soldier, able to live through the searing heat of the bombs; to walk unaffected through the purgatory hail of radiation, to assault where ordinary men would have collapsed long before.

Seligman picked his way over the rubble, his aura casting the faintest phosphorescence over the ruptured metal and plastic shreds. He paused momentarily, eyeing the blasted remnants of a fence, to which clung a sign, held to the twined metal by one rusting bolt:

NEWARK SPACEPORT
ENTRANCE BY
AUTHORIZATION ONLY

Shards of metal scrap moved under his bare feet, their razored edges rasping against the flesh, yet causing no break in the skin. Another product of the sterile white rooms and the strangely-hued fluids injected into his body?

Twenty-three young men, routine volunteers, as fit as the era of war could produce, had been moved to the solitary block building in Salt Lake City. It was a cubed structure with no windows and only one door, guarded night and day. If nothing else, they had security. No one knew the intensive experimentation going on inside those steel-enforced concrete walls, even the men upon whose bodies the experiments were being performed.

It was because of those experiments performed on him that Seligman was here now, alone. Because of the myopic little men with their foreign accents and their clippings of skin from his buttocks and shoulders, the bacteriologists and the endocrine specialists, the epidermis men and the blood-stream inspectors--because of all of them--he was here now, when no one else had lived.

Seligman rubbed his forehead at the base of the hairline. _Why_ had he lived? Was it some strain of rare origin running through his body that had allowed him to stand the effects of the bombs? Was it a combination of the experiments performed on him--and only in a certain way on him,

for none of the other twenty-two had lived--_and_ the radiation? He gave up, for the millionth time. Had he been a student of the ills of man he might have ventured a guess, but it was too far afield for a common foot-soldier.

All that counted was that when he had awakened, pinned thighs, chest and arms under the masonry of a building in Salt Lake City, he was alive and could see. He could see, that is, till the tears clouded the vision of his own sick green glow.

It was life. But at times like this, with the flickering light of his passage marked on the ash-littered remains of his culture, he wondered if it was worth the agony.

* * * * *

He never really approached madness, for the shock of realizing he was totally and finally alone, without a voice or a face or a touch in all the world, overrode the smaller shock of his transformation.

He lived. He was that fabled, joked-about Last Man On Earth. But it wasn't a joke now.

Nor had the months after the final dust of extinction settled across the planet been a joke. Those months had labored past as he searched the country, taking what little food was still sealed from radiation--though why radiation should bother him he could not imagine; habit more than anything--and disease, racing from one end of the continent in search of but one other human to share his torment.

But of course there had been no one. He was cut off like a withered arm from the body that was his race.

Not only was he alone, and with the double terror of an aura that never dimmed, sending the word, "Freak!" pounding through his mind, but there were other changes, equally terrifying. It had been in Philadelphia, while grubbing inside a broken store window that he had discovered another symptom of his change.

The jagged glass pane had ripped the shirt through to his skin--but had not damaged him. The flesh showed white momentarily, and then even that faded. Seligman experimented cautiously, then recklessly, and found that the radiations, or his treatments, or both, had indeed changed him. He was completely impervious to harm of a minor sort: fire

in small amounts did not bother him, sharp edges could no more rip his flesh than they could a piece of treated steel, work produced no callouses; he was, in a limited sense of the word, invulnerable.

The indestructible man had been created too late. Too late to bring satisfaction to the myopic butchers who had puttered unceasingly about his body. Perhaps had they managed to survive they might still not comprehend what had occurred. It was too much like the product of a wild coincidence.

But that had not lessened his agony. Loneliness can be a powerful thing, more consuming than hatred, more demanding than mother love, more driving than ambition. It could, in fact, drive a man to the stars.

Perhaps it had been a communal yearning within his glowing breast; perhaps a sense of the dramatic or a last vestige of that unconscious debt all men owe to their kind; perhaps it was simply an urge to talk to someone. Seligman summed it up without soul-searching in the philosophy, "I can't be any worse off than I am now, so why not?"

It didn't matter really. Whatever the reason, he knew by the time his search was over that he must seek men out, wherever in the stars they might be, and tell them. He must be a messenger of death to his kin beyond the Earth. They would mourn little, he knew, but still he had to tell them.

He would have to go after them and say, "Your fathers are gone. Your home is no more. They played the last hand of that most dangerous of games, and lost. The Earth is dead."

He smiled a tight, grim smile as he thought: At least I won't have to carry a lantern to them; they'll see me coming by my own glow. _Glow little glow worm, glimmer, glimmer...._

* * * * *

Seligman threaded his way through the tortured wreckage and crumpled metalwork of what had been a towering structure of shining-planed glass and steel and plastic. Even though he knew he was alone, Seligman turned and looked back over his shoulder, sensing he was being watched. He had had that feeling many times, and he knew it for what it was. It was Death, standing straddle-legged over the face of the land, casting shadow and eternal silence upon it. The only light came from the lone man stalking toward the rocket standing sentry like a pillar of January

ice in the center of the blast area.

His fingers twitched as he thought of the two years' work that had gone into erecting that shaft of beryllium. Innumerable painstaking trips to and from the junk heaps of that field, pirating pieces from other ships, liberating cases of parts from bombed-out storage sheds, relentlessly forcing himself on, even when exhaustion cried its claim.

Seligman had not been a scientist or a mechanic. But determination, texts on rocket motors, and the original miracle of finding an only partially-destroyed ship with its drive still intact had provided him with a means to leave this place of death.

It was one of the latest model ships; a _Smith_ class cruiser with conning bubble set far back on the tapered nose, and the ugly black depressions behind which the Bergsil cannons rested on movable tracks.

He climbed the hull-ladder into the open inspection hatch, finding his way easily, even without a torch. His fingers began running over the complicated leads of the drive-components, checking and re-checking what he already knew was sound and foolproof--or as foolproof as an amateur could make them.

Now that it was ready, and all that remained were these routine check-tests and loading the food for the journey, he found himself more terrified of leaving than of remaining alone till he died--and when that might be with his stamina he had no idea.

How would they receive a man as transformed as he? Would they not instinctively fear, mistrust, despise him? _Am I stalling?_ The question suddenly formed in his mind, causing his sure inspection to falter. Had he been purposely putting the takeoff date further and further ahead? Using the checks and other tasks as further attempts to stall? His head began to ache with the turmoil of his thoughts.

Then he shook himself in disgust. The tests were necessary, it was stressed repeatedly in all of the texts lying about the floor of the drive chamber.

His hands shook, but that same impetus which had carried him for two years forced him to complete the checkups. Just as dawn oozed up over the outline of the tatters that had been New York, he finished his work on the ship.

Without pause, sensing he must race, not with time, but with the doubts raging inside him, he climbed back down the ladder and began loading food boxes. They were stacked neatly to one side of a hand-powered lift he had restored. The hard rubber containers of concentrates and the bulbs of carefully-sought-out liquids made an imposing and somewhat perplexing sight.

Food is the main problem, he told himself. If I should get past a point of no return and find my food giving out, my chances would be nil. I'll have to wait till I can find more stores of food. He estimated the time needed for the search and realized it might be months, perhaps even another year till he had accrued enough from the wasted stores within any conceivable distance.

In fact, finding a meal in the city, after he had carted box after box of edibles out to the rocket, had become an increasingly more difficult job. Further, he suddenly realized he had not eaten since the day before.

The day before?

He had been so engrossed in the final touches of the ship he had completely neglected to eat. Well, it had happened before, even before the blast. With an effort he began to grope back, trying to remember the last time he _had_ eaten. Then it became quite clear to him. It leaped out and dissolved away all the delays he had been contriving. _He had not eaten in three weeks._

Seligman had known it, of course. But it had been buried so deeply that he only half-feared it. He had tried to deny the truth, for when that last seemingly insurmountable problem was removed, there was nothing but his own inadequacies to prevent his leaving.

Now it came out, full-bloom. The treatments and radiation had done more than make him merely impervious to mild perils. He no longer needed to eat! He boggled at the concept for a moment, shaken by the realization that he had not recognized the fact before.

He had heard of anaerobic bacteria or yeasts that could derive their energy from other sources, without the normal oxidation of foods. Bringing the impossible to relatively homely terms made it easier for him to accept. Maybe it was even possible to absorb energy directly. At least he felt no slightest twinge of hunger, even after three weeks of back-breaking work without eating.

Probably he would have to take along a certain amount of proteins to replenish the body tissue he expended. But as for the bulky boxes of edibles dotting the space around the ship, most were no longer a necessity.

Now that he had faced up to the idea that he had been delaying through fear of the trip itself, and that there was nothing left to stop his leaving almost immediately, Seligman again found himself caught up in the old drive.

He was suddenly intent on getting the ship into the air and beyond.

* * * * *

Dusk mingled with the blotching of the sun before Seligman was ready. It had not been stalling this time, however. The sorting and packing of needed proteins took time. But now he was ready. There was nothing to keep him on Earth.

He took one last look around. It seemed the thing to do. Sentimentalism was not one of Seligman's more outstanding traits, but he did it in preparation for anyone who might ask him, "What did it look like--at the end?" It was with a twinge of regret that he brought the fact to mind; he had never really looked at his sterile world in the two years he had been preparing to leave it. One became accustomed to living in a pile of rubble, and after a bit it no longer offered even the feel of an environment.

He climbed the ladder into the ship, carefully closing and dogging the port behind him. The chair was ready, webbing flattened back against the deep rubber pile of its seat and backrest. He slid into it and swung the control box down on its ball-swivel to a position before his face.

He drew the top webbing across himself and snapped its triple-lock clamps into place. Seligman sat in the ship he had not even bothered to name, fingers groping for the actuator button on the arm of the chair, glowing all the while, weirdly, in the half-light of the cabin.

So this was to be the last picture he might carry with him to the heavens: a bitter epitaph to a race misspent. No warning; it was too late for such puny action. All was dead and haunted on the face of the Earth. No blade of grass dared rise; no small life murmured in its

burrows and caves, in the oddly dusty skies, or for all he knew, to the very bottom of the Cayman Trench. There was only silence. The silence of a graveyard.

He pushed the button.

The ship began to rise, waveringly. There was a total lack of the grandeur he remembered when the others had left. The ship sputtered and coughed brokenly as it climbed on its imperfect drive. Tremors shook the cabin and Seligman could feel something wrong, vibrating through the chair and floor into his body.

Its flames were not so bright or steady as those other take-offs, but it continued to rise and gather speed. The hull began to glow as the rocket lifted higher into the dust-filled sky.

Acceleration pressed down on Seligman, though not as much as he had expected. It was merely uncomfortable, not punishing. Then he remembered that he was not of the same stamp as those who had preceded him.

His ship continued to pull itself up out of the Earth's atmosphere. The hull orange, then turned cherry, then straw-yellow, as the coolers within its skin fought to counteract the blasting fury.

Again and again Seligman could feel the _wrongness_ of the climb. Something was going to give!

As the bulkheads to his right began to strain and buckle, he knew what it was. The ship had not been built or re-welded by trained experts, working in teams with the latest equipment. He had been one lone determined man, with only book experience to back him. Now his errors were about to tell.

The ship passed beyond the atmosphere, and Seligman stared in horror as the plates cracked and shattered outwards. He tried to scream as the air shrieked outwards, but it was already impossible.

Then he fainted.

* * * * *

When the ship passed the moon, Seligman still sat, his body held in place by the now-constricted webbing, facing the gaping squares and

sundered metal that had been the cabin wall.

Abruptly, the engines cut off. As though it were a signal, Seligman's eyes fluttered and opened wide.

He stared at the wall, his reviving brain grasping the final truth. The last vestige of humanity had been clawed from him. He no longer needed air to live.

His throat constricted, his belly knotted, and the blood that should theoretically be boiling pounded thickly in his throat. His last kinship with those he was searching was gone. If he had been a freak before, what was he now?

The turmoil fought itself out in him as the ship sped onward and he faced what he had become, what he must do.

He was more than a messenger, now. He was a shining symbol of the end of all humanity on Earth, a symbol of the evil their kind had done. The men out there would never treasure him, welcome him, or build proud legends around him. But they could never deny him. He was a messenger from the grave.

They would see him in the airless cabin, even before he landed. They would never be able to live with him, but they would have to listen to him, and to believe.

Seligman sat in the crash-chair in the cabin that was dark except for the eerie glow that was part of him. He sat there, lonely and eternally alone. And slowly, a grim smile grew on his lips.

The bitter purpose that had been forced on him was finally clear. For two years, he had fought to find an escape from the death and loneliness of ruined Earth. Now that was impossible. One Seligman was enough.

Alone? He hadn't known the meaning of the word before! It would be his job to make sure that he was alone--alone among his people, until the end of time.

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THE AMERICAN BARN OWL.

(*Strix pratincola*).

LYNDS JONES.

The Project Gutenberg EBook of Birds and All Nature, Vol. V, No. 4, April 1899, by Various

Our barn owl belongs to the tropical and warm temperate genus *Strix*, which is scattered widely over the greater part of the earth in the tropical and subtropical parts of both hemispheres, and scatteringly into the temperate zones. In Europe one species is common as far north as the British Isles, while our own bird is found as far north as southern New England in the East, Ontario, Michigan, Wisconsin, and southern Minnesota in the interior, and Oregon and Washington on the Pacific coast. It is hardly common anywhere except in the extreme southwestern part of the United States, where it is the most abundant owl in California. It is rare or casual north of about the fortieth parallel. But two specimens have been brought to the Oberlin College Museum in twenty years, one of which was found dead in a barn a mile east of Oberlin in December of 1898.

The barn owl is the most nocturnal of all our owls, although he can see perfectly in the brightest day. Not until twilight does he issue from his secure hiding-place to do battle with the farm and orchard pests. Then he may be seen sailing noiselessly over orchard and meadow in quest of any mischievous rodent that may be menacing the farmer's prospects. He seems to single out intelligently the ones that do the most injury, destroying large numbers of pouched gophers and other annoying and destructive creatures, asking only in return to be left in peace in his hiding-place. The farmer certainly has no better friend than this owl, for he destroys poultry only when driven to it by the direst necessity. In the East, his food consists largely of rats and mice; in some parts of the South the cotton rat is the chief diet; while in the West he feeds principally upon the gopher (*Thomomys talpoides bulbivorus*) and the California ground squirrel (*Spermophilus grammurus beecheyi*), according to Prof. B. W. Evermann. It seems pretty certain that fish are sometimes captured and eaten.

This owl undoubtedly breeds, though sparingly, in all suitable localities wherever it is found, and probably migrates more or less in the northern part of its range. In Europe it nests in old ruins, towers, and abutments of bridges, but our American species finds few

such places, so he resorts to hollow trees, caves, crevices in rocks, and banks, and even to burrows in the level ground, as we find to be the case in parts of the West. The burrows are undoubtedly the deserted burrows of some other animal. In the eastern parts of the country the owls frequently nest in buildings. It is well known that a pair occupied one of the towers of the Smithsonian building in the city of Washington in 1890, raising a brood of seven young. It is stated that the period of incubation is from three to three and a half weeks, and that brooding begins with the deposit of the first egg; thus there may be fresh eggs and young in the same nest. This accounts for the long period of incubation.

The eggs are pure white, usually from four to seven in number, rarely twelve. They are rather longer in proportion than those of the other owls--in about the proportion of 1.30×1.70 . But the average size is variously given by the various authors.

It seems a little curious that there should be such a marked difference between the hawks and owls as regards nest material. They belong to the same order of birds, and yet the hawks build their own nests, collecting the material and arranging it much after the fashion of higher birds, while the owls make practically no nest, at the most collecting a little material and scattering it about with little regard for arrangement. But the difficulty disappears when we realize that the owls have probably always nested in hollows which require no nest material, while the hawks, if they ever nested in hollows, have long ceased to do so, building their nests among the branches of trees, where a relatively large amount of material is necessary. The few species of hawks which now nest in hollows have gone back to that method after a long period of open nesting and have retained the nest material even here where it seems unnecessary.

The monkey-like appearance of this owl, emphasized by his tawny color and screeching voice, gives him a decidedly uncanny appearance. His plumage is unusually soft and fluffy, but is too thin to enable him to withstand the rigors of a northern winter. Curiously enough, the feathers on the back of his tarsus grow up instead of down, giving that part of his plumage a rather ungroomed appearance. One edge of his middle toe-nail is toothed like a comb.

During the nesting season only a single pair can be found in a place, but at other times the species is more or less gregarious in the regions in which it is numerous. Often a dozen individuals may be found in a company. The extreme seclusiveness of the birds during the

day makes it very difficult to find them, and they are undoubtedly more numerous than generally reported, and are likely to be present in many places where their presence is not now suspected. They seek the darkest and most secluded corner possible and remain quiet all day. Their noiseless flight might easily be mistaken for that of the whippoorwill. Let us hope that the good qualities of this owl will be fully recognized before his hiding-place is discovered.

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THE BIRDS AND THE BEES

by Dave E. Fisher

_Which goes to prove that, in some
instances, being heroic is easy!_

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I was wandering among the tall grass of the slopes, listening to the soft whistling of the wind; allowing the grass to caress my toga and thighs. It was a day soft and clear; a day accepted by the young, cherished by we old. Across the gently undulating hills stood the magnificent Melopolis, encradling the Oracle of Delni. I do not, of course, believe in the gods per se; still there is a grandeur in the very stones that transcends their human sculptors, and it is no wonder to me that many cling tenaciously, and ignorantly, to the old religion. Cling to the gods of old, who drew man upward from wherever he began. In whose names Man killed and plundered, while struggling up. In whose names Man finally left this earth, to seek his cousins among the stars.

But of course there were no cousins. There was nothing. And Man returned, and settled down to live. Saddened, but resigned and content to live in peace with his knowledge and his power. Gone now are all the ancient evils, wars, emergencies.

"Sias! Sias--" And they were upon me.

That is, Xeon was upon me. But I knew that where Xeon is, Melia must soon appear. And indeed it was but a moment before Melia slipped through the high grass to stand at his side. Their youthful voices were babbling in excitement.

Melia was a She, with the swelling breasts that were, so tradition states, quite prevalent among members of the race long ago, and are seldom seen today. Indeed, Melia was on this account made the butt of many jokes and, I fear, would have had a lonely life of it had it not been for the friendship of Xeon.

"Sias," they were saying, "the Maternite's gone."

I stared in amazement.

"Gone? It cannot be gone. It has always been--"

"Oh my gods!" Xeon shouted. "I tell you it's gone! Will you--"

Melia interrupted him quietly. "Xeon, will you lose all respect for the Elder?" Then turned to me, and said calmly, "The watcher at the Maternite Machine, it appears, has been drunk. The heat rose above the warning, continued to rise, and then--poof. Everything has evaporated in Maternite. All the Prelife is gone."

"All of it?" I asked.

"There is nothing left," Melia insisted. "Can more be made? And if not, what will happen with no more children?"

"That is for the priests to say, not I," I replied. In moments of emergency, it is wise to speak with caution. That is, I suppose so. I have never before been in a real emergency.

* * * * *

A man my age does not hurry in the heat of the midday sun--maddugs nenglishmin go out in the midday sun, as the ancients say, although I often wonder why--but Xeon and Melia ran all the way down to the city. They are of an age to enter manhood, and have all the energy such young men do.

As we entered the city, we were surrounded by confusion and

consternation. And can the simple people be blamed? They were aware that they stood in the midst of an unprecedented happening; indeed, an emergency. For a machine had failed!

Not in the memory of the eldest among us has a machine failed. They were created so long ago, indeed, that the ignorant believe them to have been constructed by the gods themselves. And never, so far as I know, has one failed. Small wonder that the watcher had been negligent. Indeed, the watcher is more a tradition than a necessity. Besides, had he been sober, he would not have known what to do. For who knows the mysterious workings of the machines?

* * * * *

I hastened to the City Hall and found the Conclave assembled, waiting for me to bring them to order. Xeon and Melia stopped as I mounted the steps, but I smiled and motioned them in. They accompanied me past the marble pillars into the cool recesses of the Hall, then seated themselves on the floor as I took my place by the great table.

Well, you know how these things are. At such a time, many men feel impelled to make speeches, and one must not be disrespectful. Prayers and supplications were offered to the gods, priests were sent to sacrifice, and finally, as the light of the sun was falling between the pillars, the High Priest of the Maternite Machine was heard.

He rambled through the customary opening remarks and then, continually smoothing his white beard--of which he is excessively proud--approached the crux of the matter and the Conclave finally heard the facts it had assembled to hear. By this time, unfortunately, many of the Conclave had departed for home and supper. Yet perhaps it is for the best, for those left were the most earnest and intelligent.

"I would not bore you," he said, "with details of which only the gods are sure. Know, then, that once granted a few cells of Prelife, it is an easy matter for the Maternite Machine to add more and more; thus assuring us, as has always been, a continuous source of Prelife to be born by the Generating Machine as children. The machines bear the exact number of children each year to balance the number of us whom the gods claim. Such it has always been from time immemorial."

A murmur of assent and approval of these virtuous words whispered around the Hall.

"But now," he continued, however, with less assurance and indeed with even a stutter here and there, "an unprecedented situation has arisen. Indeed, I might call it an emergency. For the M-Maternite Machine has actually failed."

Cries of "Treason" sprang up, and I fear it might have gone hard for the priest had I not been able to insure order.

"That is not the worst," he cried, as if in defiance. "All the Prelife has been dried up. It will not function. There is no more. And there will be no more children!"

At this I feared the Conclave was about to riot. It is at such times that I most revere the wisdom of the ancients, who decreed seventy years the minimum age for a member of the Conclave. They shouted and began to beat their fists, but for how long can a man of seventy years roar like a youngster? They quieted, breathing heavily, and I asked,

"Is there no way, then, to produce more Prelife in order that the machines may produce more children for us?"

"As I have said," he replied, "give the machines but a bit of Prelife and they will produce more. But take away that least bit, and they are helpless."

Such heresy could have brought a sad end to the priest had not the Conclave been so exhausted by the events of the day. We leaned back to think.

Rocsates leaned forward and asked, "Must there not--must there not have been a beginning to Prelife? For the Machine, it seems, cannot make it; and yet it came from somewhere."

"Riddles are not called for," I answered severely.

"Are not riddles often the beginning of knowledge?" he asked, in that irritating dumber-than-thou attitude of his. "Must there not, long ago, have been a source of Prelife: a source now forgotten? And may it not even now--should we discover it--be available to us? I am reminded of the story of the animals of old--"

"I fear your mind is wandering, Rocsates," I was forced to interrupt. "I know well the legend of the animals, but what does it have to do--" The heads of the Conclave were turning to me, quizzically. I

hastened to explain the legend of the animals. "It is said that many thousands of years ago, time without reckoning, there existed on the earth creatures who were alive like us, and yet not like us. It is said they had four legs or more, and no arms, were covered with hair, and although not mute, they could not speak."

Rocsates' voice made itself heard. "It is true. Such creatures did indeed exist. It is recorded most scientifically in the films."

"If it be so," I said, quieting the hub-bub that followed, "and I would not doubt your word, Rocsates, for all know you are the wisest of men--if it were so, then, what of it?"

"May it not be," Rocsates put in, "that these animals had no machines to reproduce their kind? For surely the gods would not grant machines to such creatures. And indeed, if they had Maternite Machines, why then we would yet have these animals among us."

"And how, then, did these animals reproduce?" I asked.

"How, indeed? And is there not a legend--admitted only a legend--that says there was a time before the machines, and before the Maternite Machine, and that at such a time both the animals and Men reproduced from within their own bodies?"

At this two members of the Conclave fell immediately into a faint, and I would gladly have joined them. I hoped that the youngsters, Xeon and Melia, had not heard, but as I turned they were listening most attentively to Rocsates, who, amid cries of "Heresy" and "Treason", went on:

"I should like to ask the Conclave for permission to search the ancient records, in the hope of finding some such knowledge that would prove or disprove my words."

"You wish to search the films--" I began.

"Not the films, Sias, but the books."

Gods, this Rocsates! The books, as well he knows, are so ancient, and so delicate, that they are kept in an air-tight tomb; lest, being handled, they be destroyed and all knowledge within them lost. Therefore, they have not been read in the known history of our race. And Rocsates has been anxious for an excuse--

"Sias," he went on, "if there exists such knowledge as I seek, is it not indeed lost to the memory of Man? And if so, are not the books the only place where it may be found?"

Rocsates, it is suspected, will never ask a question unless he knows the answer beforehand. And so I acquiesced, and agreed, and granted permission. And with much misgiving and foreboding of evil, the Conclave adjourned.

* * * * *

Several weeks elapsed before Rocsates requested that the Conclave meet. I called the meeting at dawn and so it was yet early in the afternoon when formalities were concluded and Rocsates granted leave to speak.

"Some of those among you are She's," he began. "And you know you are different from the rest of us. To the advantage, your skin is fairer and your features more often handsomer than ours. To the disadvantage, your excretory system is not so mechanically dextrous as ours. And, you may say, why should this not be so? There is, indeed, no reason why we should all be identical. Perforce you have the advantage, perforce we do. Yet there is one other distinction.

"Some among you She's have the swelling of the breasts. And does there exist no reason for this? Was there not, perhaps in ancient times, a cause for this? Do you not wonder, She's, whence you come and for what reason?"

"Rocsates," I interrupted. "All this is fascinating, of course. But if you could be quick--"

"Of course," he replied. "In the course of my reading I have read many books, and while they are all vague on the subject, this I have discovered:

"That there was indeed a time before the machines, in fact the books were created in that time, for not one of them mentions the machines. Then reproduction was carried on by individuals, without help of the then nonexistent machines. The She's are not wanderers from another land, but they have lived with us for all time; they are not another race, but we are all types of one race. And the fact of reproduction is somehow intimately related to the physical distinctions of the She's!"

These last sentences were shouted to be heard above the roar of the crowd. Yet when Rocsates stopped, so also did the noise, so shocked and amazed at his words were they. And I confess, myself also.

"In fact," Rocsates added, sitting down, "this process of reproduction seems to have been so simple that there was once a problem of over-population."

Order was lost among the Conclave as each man turned to speak to his neighbor, and for some time I could not restore order. I realized that something had to be done to save Rocsates before the outrage of the assembled overwhelmed him.

"It seems," I shouted, "that there is a flaw in your logic." For if such there was, I was hopeful of dismissing the entire affair with no harm done. "For if people reproduced too often, why then this reproduction must have been a pleasant thing to do; otherwise they would not have done so to excess. And if it was a pleasant thing to do, where is the necessity for the machines, and why were they created?"

Rocsates seemed perplexed by this problem, whereupon Xeon, who together with Melia were at the Conclave without permission, shouted, "Perhaps the process of reproduction was of _such_ a pleasure that the Conclave ruled it to be a sin? And therefore the machines were necessary!"

At this impudence the Conclave dissolved in an uproar, and I was beyond power to restrain them from placing Xeon under arrest. Privately, however, I had to admit that his supposition was a possibility, and thus I authorized Rocsates to continue his search.

* * * * *

Now indeed I was sorely worried concerning Xeon, for he must languish in the dungeon until the Conclave is satisfied to release him, and this they cannot do until they meet again.

I needed a sufficient excuse to call a meeting of the Conclave, whereupon I might argue for the lad. When I heard that Rocsates again desired audience, I immediately proclaimed a meeting of the Conclave to be held the next day at dawn, and so that night slept well.

The Conclave had come to order and formalities had been initiated when Rocsates entered and took his place. He clutched under one shoulder a thin, rectangular object, but that is not what impressed me. His

appearance--he looked as if he had not slept of late, nor eaten either. His eyes were sunken, and his features had doubled in age. He was bent and tired. But it was his eyes. There was a horror in them.

I was shocked, and could not help staring at him. And then the formalities were over. I intended to speak for Xeon, but Rocsates was on his feet and I gave way.

"I have indeed discovered the secret of reproduction," he began. "After many searchings, I came upon this--" and he held forth the object he had carried in. "It is a book. It is entitled, 'Living a Normal Sex Life.' It seems to be some sort of a do-it-yourself pamphlet." He dropped the book on the table and rubbed his hands over his eyes.

There was something in the man's behavior that commanded everyone's attention. He went on, speaking low. "The word 'Sex' is not defined, but it seems to mean...." His words trailed off. He was obviously unsure of how to continue. "I had better start at the beginning, I suppose," he said. "You see, once upon a time there were birds and bees...."

* * * * *

When he finished the Conclave sat in horrified silence. His words, with all their horror, had the ring of truth and there were no cries of 'Heresy'. There was only stunned disbelief and the beginnings of nausea.

It is the mark of honor that a leader shall carry on when others fear to move. I cleared my throat.

"Shall not these organs which you mention have atrophied by now? With no use throughout all these generations, will they not have evolved into nothingness?"

"I do not think so," Rocsates replied after a while. "What to us is an eon, to evolution is but an instant. And then the swelling of the breasts, I believe, proves that there is still reproductive activity in some, at least, of the She's."

We sat shaking our heads, bowed under terrible reality.

"Then we must experiment," I said. "But whom could we ask to submit to such horror?"

"I have already taken the liberty of asking for volunteers," Rocsates replied. "The She, of course, must be one with the swelling of the breasts. Melia has volunteered, on condition that Xeon be released from dungeon. Are there any objections?"

There were none, of course. Who would refuse a boon to one who would undergo such an ordeal for the City?

"And who will be the partner?" I asked.

"In all honor, could Xeon allow Melia to surpass him in courage? It shall be he," Rocsates said. And with his word the two entered the Hall and stood, noble and naked.

Rocsates gestured to the table, and Melia started to climb upon it, but Xeon stepped forward.

"My lords," he said, "would not better results be obtained were we to conduct the experiment in the fields before the Oracle of Delni, that the gods may help us?"

His glance reached into my soul, and I was proud of Xeon. A true friend, he thought even now of the comfort of Melia. The marble table was indeed hard, and from Rocsates' description it seemed that Melia's position would be as uncomfortable as it would be undignified. The soft fields might be some slight help.

I voiced my assent, and the entire Conclave adjourned to the fields.

* * * * *

It was nearly dark when we walked home, Rocsates and I, arm in arm. It had been a horrible day. The inhuman indignity, the cries--

We tarried before my home, leaned on the stone, stared at the first stars.

"They seemed finally to accomplish all the book described," I muttered.

"They may indeed have succeeded," Rocsates replied. "There is mentioned a time lapse which is necessary. The child does not appear immediately."

"It doesn't matter," I said disconsolately. "Who could ask them to go through such an ordeal again?"

And then I looked down to earth again, and saw them standing before me. Melia cast her eyes down, and would not raise them. Xeon held his arm about her shoulders, as if to protect her, but I know not from whom.

"Sias," he said. Then stopped, embarrassed.

I waited, and Rocsates was silent, and he continued.

"Sias, we come to tell.... We will...." He raised his eyes to mine and said manfully, "We shall try again."

I am afraid that tears came to my eyes. Such sacrifice--

"We beg one favor," Xeon went on. "We are agreed that--Well, we should like to be left alone, in private, to try."

"Of course," I replied. Anything they might want they could have. My relief and gratitude must have showed, for Xeon took a deep breath and spoke again.

"We do not deserve praise, Sias," he said. "The truth is, we ... we sort of enjoy it."

I watched them turn and wander off together under the stars.

My heart has a warmth in it, and I no longer fear for the future of our race when our young people can show such nobility and sacrifice.

=====

EXOTIC BEES

The Project Gutenberg eBook of The Honey-Bee, by Edward Bevan

Bees are, in all probability, the most universal of all animals; and notwithstanding their impatience of cold, they seem adapted to live in all climates. They are accordingly to be met with in every quarter of the globe, and in every quarter they seem to flourish, if duly attended to.

In all tropical climates there are little black bees without stings.
Those of Guadeloupe are only half the size of those in Europe, and are rounder in their form. They build in hollow trees, or in the cavities of rocks by the sea-side, where they lay up their honey in cells about

the size and shape of a pigeon's egg; these cells are of a black or deep violet colour, and joined together, so as to leave no space between them; they hang in clusters almost like a bunch of grapes; each cell somewhat resembles a small bottle or bladder; when filled with honey the cell is closed up.

The honey collected by these bees is said not to be so unpalatable nor so surfeiting as that of Europe. By unpalatable I conceive the writers merely to mean, that it has less of that peculiar flavour which European honey possesses. A writer in the 15th volume of the Philosophical Transactions, states that their honey is always in a fluid state, and as clear as rock water, forming an agreeable beverage, which taken on an empty stomach in the quantity of about half a pint, acts medicinally in about two hours, but not so when taken with the meals.

There is a species of bees in Guiana which gather very delicious honey, and have no stings. These also construct their combs in a different manner from the hive-bee of our hemisphere. According to Huber's translator, _there are bees in India that construct under the boughs of a tree a single comb of very large dimensions_. The most interesting account of exotic bees that I have met with, is in Mr. Basil Hall's highly instructive and entertaining Journal written on the coasts of Chili, Peru and Mexico, in 1820, -1, and -2, of which I shall here give a transcript.

"From the Plaza, we went to a house where a bee-hive of the Country was opened in our presence. The bees, the honey-comb, and the hive, differ essentially from those in England. The hive is generally made out of a log of wood from two to three feet long and eight or ten inches in diameter, hollowed out, and closed at the ends by circular doors, cemented closely to the wood, but capable of being removed at pleasure.

"Some persons use cylindrical hives, made of earthenware, instead of the clumsy apparatus of wood; these are relieved by raised figures and circular rings, so as to form rather handsome ornaments in the verandah of a house, where they are suspended by cords from the roof, in the same manner that the wooden ones in the village are hung to the eaves of the cottage. On one side of the hive, half-way between the ends, there is a small hole made, just large enough for a loaded bee to enter, and shaded by a projection to prevent the rain from trickling in. In this hole, generally representing the mouth of a man, or some monster, the head of which is moulded in the clay of the hive, a bee is constantly stationed, whose office is no sinecure[J], for the hole is so small, he has to draw back every time a bee wishes to enter or to leave the hive. A gentleman

told me that the experiment had been made, by marking the sentinel; when it was observed that the same bee continued at his post a whole day.

[Footnote J: If the Mexican bees enter the hives with as much rapidity and in as great numbers as Reaumur states they do in this part of the world, it would indeed be no sinecure. He observes that the population of a hive amounts to 18,000, and that a hundred enter in a minute; if as many go out in the same time, I think the sentinel must rather stand on one side of the entrance than within it.]

"When it is ascertained by the weight that the hive is full, the end pieces are removed, and the honey withdrawn. The hive we saw opened was only partly filled, which enabled us to see the œconomy of the interior to more advantage. The honey is not contained in the elegant hexagonal cells of our hives, but in wax bags, not quite so large as an egg. These bags or bladders are hung round the sides of the hive, and appear about half full, the quantity being probably just as great as the strength of the wax will bear without tearing. Those near the bottom being better supported, are more filled than the upper ones. In the centre of the lower part of the hive, we observed an irregular-shaped mass of comb furnished with cells, like those of our bees, all containing young ones, in such an advanced state that when we broke the comb and let them out, they flew merrily away. During this examination of the hive, the comb and the honey were taken out, and the bees disturbed in every way; but they never stung us, though our faces and hands were covered with them. It is said, however, that there is a bee in the country which does sting; but the kind we saw seem to have neither the power nor the inclination, for they certainly did not hurt us; and our friends said they were always 'muy manso,' very tame, and never stung any one. The honey gave out a rich aromatic perfume, and tasted differently from ours, but possessed an agreeable flavour."

From the periodicals of the last year, I have observed that there has been an importation of the stingless bees into this country. I doubt the success of their establishment here, as the fruits of their labours may very soon become the prey of wasps and corsair bees, and even of the hive-bees which, in a dearth of honey or when from a paucity of numbers a hive is weakly defended, will commit depredations upon one another. The stingless bees having no weapon of defence which enables them to cope with armed assailants must soon be exterminated. In their native clime, where there is an abundance of sweets, no temptations to predatory attack may occur; but in our hemisphere, as Buffon has observed, there are hundreds of lazy creatures, fond of honey and disliking labour, that would, but for the weapons of defence possessed by our bees, invade their

hives and carry off the treasures.

Honey-bees do not appear to have been among the native productions of North America, though they have now become general throughout that continent. When established there, they extended themselves somewhat in advance of the white population; in consequence of which they were called by the native Indians, the white man's flies, and were regarded as indicating the approach of European settlements.--Jefferson's Virginia.

An elegant modern writer has observed upon this subject, that "a few years ago the hum of a bee had never been heard on the western side of Alleghany Mountains: but that a violent hurricane having carried several swarms over that lofty ridge, they found there a new unexhausted country, singularly favourable to their propagation, where they have multiplied, till the whole of those boundless savannahs and plains have been colonized by these indefatigable emigrants."

From what I have said above, it would seem that the bees of all tropical climates store their honey in cells or bags of large dimensions; but from Mr. Basil Hall's account it appears that the bees of South America build small cells also, resembling those of our hive-bees; and in all probability this is the case with those of other hot climates, and that these small cells are merely used as receptacles for the young brood.

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BUTTERFLY METAMORPHOSIS

The Project Gutenberg eBook of Life Among the Butterflies, by Vance Randolph

Some insects, grasshoppers for example, pass through an _incomplete metamorphosis_; that is, the young grasshopper is very much like its parents except as regards size. This is the same sort of development found among birds, reptiles, and other vertebrates. The egg of a butterfly, however, does not hatch into a miniature replica of its parents, but into an altogether different sort of creature, which must pass through a _complete metamorphosis_ before it becomes a butterfly. To put the matter briefly, there are four distinct stages in the life of a butterfly: the egg, the caterpillar, the chrysalis, and the imago, or butterfly proper.

THE FIRST STAGE OR EGG

Female butterflies are equipped with organs called ovaries which produce ova, and male butterflies have testes which produce sperm. By an act called copulation (in which the male and female abdomens are locked together by appropriate appendages) the sperm of the male is introduced into the body of the female. A single spermatozoon fuses with each ovum, and the result is a fertilized egg. The female deposits the egg upon a green leaf, and as a rule each species is limited to one or two particular kinds of plants. Butterfly eggs are small, but always large enough to be seen with the naked eye, and they vary widely in shape and color as well as in size.

THE SECOND OR LARVAL STAGE

[Illustration: Fig. II.--The Viceroy (*Basilarchia disippus*), an example of the family Nymphalidae, or four-footed butterflies. This is the butterfly that mimics the Monarch; see section on Protective Mimicry. A, egg; B, caterpillar; C, chrysalis; D, imago.]

Most butterfly eggs hatch within a week or two, producing worm-like larvae called *caterpillars*, which differ in appearance according to the species, but whose general characteristics are well known. The principal business of a caterpillar is to eat; no sooner has it emerged from the egg than it devours the egg-shell, and then sets to work on the leaves of the food plant. Its growth is so rapid that the outer skin must soon be shed, and this shedding process is known as moulting. Most caterpillars moult about four times. The caterpillar stage usually lasts only a month or so, but there are a few species which hibernate and spend the winter as caterpillars.

THE THIRD OR PUPAL STAGE

When the caterpillar is fully grown it spins a little silken button on some solid object, hangs itself up by the tail, and undergoes a final moult. When the old skin peels off this time it reveals, not a caterpillar with a bright new skin, but a different sort of creature altogether. The apparently lifeless pupa or *chrysalis* shows some of the characteristics of a butterfly, but the wings and legs are folded up, the antennae are cemented fast against the body, and the whole structure covered by a horny, tight-fitting sheath. This state of affairs usually lasts only three or four weeks, but some butterflies, particularly in temperate climates, pass the winter in the pupal state.

THE FOURTH STAGE OR IMAGO

When the chrysalis stage is over the outer skin bursts open about the head, and the _imago_--the butterfly proper--crawls out. The newly emerged butterfly is a sorry-looking specimen; the wings are very small and flaccid, and it can do no more than cling to some convenient support, usually the empty skin of the chrysalis. After a while, however, the body juices flow out into the wings, which expand and harden, and in a few hours the young butterfly is flitting from flower to flower with its fellows.

Ordinarily the imago does not live long--often only a few days. Just as the caterpillar's sole business is to eat, the mature butterfly has only one important function, and that is reproduction. It speedily finds a mate (that's what its wings are for), contributes its quota of ova or sperm to produce another generation of caterpillars, and its ephemeral existence as a butterfly is over.

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BUTTERFLY 9

by Donald Keith

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Jeff needed a job and this man had a job to
offer--one where giant economy-size trouble

had labels like fakemake, bumsy and peekage!

I

At first, Jeff scarcely noticed the bold-looking man at the next table. Nor did Ann. Their minds were busy with Jeff's troubles.

"You're still the smartest color engineer in television," Ann told Jeff as they dallied with their food. "You'll bounce back. Now eat your supper."

"This beanery is too noisy and hot," he grumbled. "I can't eat. Can't talk. Can't think." He took a silver pillbox from his pocket and fumbled for a black one. Those were vitamin pills; the big red and yellow ones were sleeping capsules. He gulped the pill.

Ann looked disapproving in a wifely way. "Lately you chew pills like popcorn," she said. "Do you really need so many?"

"I need something. I'm sure losing my grip."

Ann stared at him. "Baby! How silly! Nothing happened, except you lost your lease. You'll build up a better company in a new spot. We're young yet."

* * * * *

Jeff sighed and glanced around the crowded little restaurant. He wished he could fly away somewhere. At that moment, he met the gaze of the mustachioed man at the next table.

The fellow seemed to be watching him and Ann. Something in his confident gaze made Jeff uneasy. Had they met before?

Ann whispered, "So you noticed him, too. Maybe he's following us. I think I saw him on the parking lot where we left the car."

Jeff shrugged his big shoulders. "If he's following us, he's nuts. We've got no secrets and no money."

"It must be my maddening beauty," said Ann.

"I'll kick him cross-eyed if he starts anything," Jeff said. "I'm just

in the mood."

Ann giggled. "Honey, what big veins you have! Forget him. Let's talk about the engineering lab you're going to start. And let's eat."

He groaned. "I lose my appetite every time I think about the building being sold. It isn't worth the twelve grand. I wouldn't buy it for that if I could. What burns me is that, five years ago, I could have bought it for two thousand."

"If only we could go back five years." She shrugged fatalistically. "But since we can't--"

The character at the next table leaned over and spoke to them, grinning. "You like to get away? You wish to go back?"

Jeff glanced across in annoyance. The man was evidently a salesman, with extra gall.

"Not now, thanks," Jeff said. "Haven't time."

The man waved his thick hand at the clock, as if to abolish time. "Time? That is nothing. Your little lady. She spoke of go back five years. Maybe I help you."

He spoke in an odd clipped way, obviously a foreigner. His shirt was yellow. His suit had a silky sheen. Its peculiar tailoring emphasized the bulges in his stubby, muscular torso.

Ann smiled back at him. "You talk as if you could take us back to 1952. Is that what you really mean?"

"Why not? You think this silly. But I can show you."

Jeff rose to go. "Mister, you better get to a doctor. Ann, it's time we started home."

* * * * *

Ann laid a hand on his sleeve. "I haven't finished eating. Let's chat with the gent." She added in an undertone to Jeff, "Must be a psycho--but sort of an inspired one."

The man said to Ann, "You are kind lady, I think. Good to crazy people."

I join you."

He did not wait for consent, but slid into a seat at their table with an easy grace that was almost arrogant.

"You are unhappy in 1957," he went on. "Discouraged. Restless. Why not take trip to another time?"

"Why not?" Ann said gaily. "How much does it cost?"

"Free trial trip. Cost nothing. See whether you like. Then maybe we talk money." He handed Jeff a card made of a stiff plastic substance.

Jeff glanced at it, then handed it to Ann with a half-smile. It read:

4-D TRAVEL BEURO
Greet Snader, Traffic Ajent

"Mr. Snader's bureau is different," Jeff said to his wife. "He even spells it different."

Snader chuckled. "I come from other time. We spell otherwise."

"You mean you come from the future?"

"Just different time. I show you. You come with me?"

"Come where?" Jeff asked, studying Snader's mocking eyes. The man didn't seem a mere eccentric. He had a peculiar suggestion of humor and force.

"Come on little trip to different time," invited Snader. He added persuasively, "Could be back here in hour."

"It would be painless, I suppose?" Jeff gave it a touch of derision.

"Maybe not. That is risk you take. But look at me. I make trips every day. I look damaged?"

As a matter of fact, he did. His thick-fleshed face bore a scar and his nose was broad and flat, as if it had been broken. But Jeff politely agreed that he did not look damaged.

Ann was enjoying this. "Tell me more, Mr. Snader. How does your time

travel work?"

"Cannot explain. Same if you are asked how subway train works. Too complicated." He flashed his white teeth. "You think time travel not possible. Just like television not possible to your grandfather."

Ann said, "Why invite us? We're not rich enough for expensive trips."

"Invite many people," Snader said quickly. "Not expensive. You know Missing Persons lists, from police? Dozens people disappear. They go with me to other time. Many stay."

"Oh, sure," Jeff said. "But how do you select the ones to invite?"

"Find ones like you, Mr. Elliott. Ones who want change, escape."

* * * * *

Jeff was slightly startled. How did this fellow know his name was Elliott?

Before he could ask, Ann popped another question. "Mr. Snader, you heard us talking. You know we're in trouble because Jeff missed a good chance five years ago. Do you claim people can really go back into the past and correct mistakes they've made?"

"They can go back. What they do when arrive? Depends on them."

"Don't you wish it were true?" she sighed to Jeff.

"You afraid to believe," said Snader, a glimmer of amusement in his restless eyes. "Why not try? What you lose? Come on, look at station. Very near here."

Ann jumped up. "It might be fun, Jeff. Let's see what he means, if anything."

Jeff's pulse quickened. He too felt a sort of midsummer night's madness--a yearning to forget his troubles. "Okay, just for kicks. But we go in my car."

Snader moved ahead to the cashier's stand. Jeff watched the weasel-like grace of his short, broad body.

"This is no ordinary oddball," Jeff told Ann. "He's tricky. He's got some gimmick."

"First I just played him along, to see how loony he was," Ann said. "Now I wonder who's kidding whom." She concluded thoughtfully, "He's kind of handsome, in a tough way."

II

Snader's "station" proved to be a middle-sized, middle-cost home in a good neighborhood. Lights glowed in the windows. Jeff could hear the whisper of traffic on a boulevard a few blocks away. Through the warm dusk, he could dimly see the mountains on the horizon. All was peaceful.

Snader unlocked the front door with a key which he drew from a fine metal chain around his neck. He swept open the front door with a flourish and beamed at them, but Ann drew back.

"Walk into my parlor, said the spider to the fly," she murmured to Jeff. "This could be a gambling hell. Or a dope den."

"No matter what kind of clip joint, it can't clip us much," he said. "There's only four bucks in my wallet. My guess is it's a 'temple' for some daffy religious sect."

They went in. A fat man smiled at them from a desk in the hall. Snader said, "Meet Peter Powers. Local agent of our bureau."

The man didn't get up, but nodded comfortably and waved them toward the next room, after a glance at Snader's key.

The key opened this room's door, too. Its spring lock snapped shut after them.

The room was like a doctor's waiting room, with easy chairs along the walls. Its only peculiar aspects were a sign hanging from the middle of the ceiling and two movie screens--or were they giant television screens?--occupying a whole wall at either end of the room.

The sign bore the number 701 in bright yellow on black. Beneath it, an arrow pointed to the screen on the left with the word _Ante_, and to the right with the word _Post_.

Jeff studied the big screens. On each, a picture was in motion. One appeared to be moving through a long corridor, lined with seats like a railroad club car. The picture seemed to rush at them from the left wall. When he turned to the right, a similar endless chair-lined corridor moved toward him from that direction.

"Somebody worked hard on this layout," he said to Snader. "What's it for?"

"Time travel," said Snader. "You like?"

"Almost as good as Disneyland. These movies represent the stream of time, I suppose?"

* * * * *

Instead of answering, Snader pointed to the screen. The picture showed a group of people chatting in a fast-moving corridor. As it hurtled toward them, Snader flipped his hand in a genial salute. Two people in the picture waved back.

Ann gasped. "It was just as if they saw us."

"They did," Snader said. "No movie. Time travelers. In fourth dimension. To you, they look like flat picture. To them, we look flat."

"What's he supposed to be?" Jeff asked as the onrushing picture showed them briefly a figure bound hand and foot, huddled in one of the chairs. He stared at them piteously for an instant before the picture surged past.

Snader showed his teeth. "That was convict from my time. We have criminals, like in your time. But we do not kill. We make them work. Where he going? To end of line. To earliest year this time groove reach. About 600 A.D., your calendar. Authorities pick up when he get there. Put him to work."

"What kind of work?" Jeff asked.

"Building the groove further back."

"Sounds like interesting work."

Snader chortled and slapped him on the back. "Maybe you see it some

day, but forget that now. You come with me. Little trip."

Jeff was perspiring. This was odder than he expected. Whatever the fakery, it was clever. His curiosity as a technician made him want to know about it. He asked Snader, "Where do you propose to go? And how?"

Snader said, "Watch me. Then look at other wall."

He moved gracefully to the screen on the left wall, stepped into it and disappeared. It was as if he had slid into opaque water.

Jeff and Ann blinked in mystification. Then they remembered his instruction to watch the other screen. They turned. After a moment, in the far distance down the long moving corridor, they could see a stocky figure. The motion of the picture brought him nearer. In a few seconds, he was recognizable as Snader--and as the picture brought him forward, he stepped down out of it and was with them again.

"Simple," Snader said. "I rode to next station. Then crossed over. Took other carrier back here."

"Brother, that's the best trick I've seen in years," Jeff said. "How did you do it? Can I do it, too?"

"I show you." Grinning like a wildcat, Snader linked his arms with Ann and Jeff, and walked them toward the screen. "Now," he said. "Step in."

* * * * *

Jeff submitted to Snader's pressure and stepped cautiously into the screen. Amazingly, he felt no resistance at all, no sense of change or motion. It was like stepping through a fog-bank into another room.

In fact, that was what they seemed to have done. They were in the chair-lined corridor. As Snader turned them around and seated them, they faced another moving picture screen. It seemed to rush through a dark tunnel toward a lighted square in the far distance.

The square grew on the screen. Soon they saw it was another room like the waiting room they had left, except that the number hanging from the ceiling was 702. They seemed to glide through it. Then they were in the dark tunnel again.

Ann was clutching Jeff's arm. He patted her hand. "Fun, hey? Like Alice

through the looking-glass."

"You really think we're going back in time?" she whispered.

"Hardly! But we're seeing a million-dollar trick. I can't even begin to figure it out yet."

Another lighted room grew out of the tunnel on the screen, and when they had flickered through it, another and then another.

"Mr. Snader," Ann said unsteadily, "how long--how many years back are you taking us?"

Snader was humming to himself. "Six years. Station 725 fine place to stop."

For a little while, Jeff let himself think it might be true. "Six years ago, your dad was alive," he mused to Ann. "If this should somehow be real, we could see him again."

"We could if we went to our house. He lived with us then, remember? Would we see ourselves, six years younger? Or would--"

Snader took Jeff's arm and pulled him to his feet. The screen was moving through a room numbered 724.

"Soon now," Snader grunted happily. "Then no more questions."

He took an arm of each as he had before. When the screen was filled by a room with the number 725, he propelled them forward into it.

Again there was no sense of motion. They had simply stepped through a bright wall they could not feel. They found themselves in a replica of the room they had left at 701. On the wall, a picture of the continuous club-car corridor rolled toward them in a silent, endless stream.

"The same room," Ann said in disappointment. "They just changed the number. We haven't been anywhere."

* * * * *

Snader was fishing under his shirt for the key. He gave Ann a glance that was almost a leer. Then he carefully unlocked the door.

In the hall, a motherly old lady bustled up, but Snader brushed past her. "Official," he said, showing her the key. "No lodging."

He unlocked the front door without another word and carefully shut it behind them as Jeff and Ann followed him out of the house.

"Hey, where's my car?" Jeff demanded, looking up and down the street.

The whole street looked different. Where he had parked his roadster, there was now a long black limousine.

"Your car is in future," Snader said briskly. "Where it belong. Get in." He opened the door of the limousine.

Jeff felt a little flame of excitement licking inside him. Something was happening, he felt. Something exciting and dangerous.

"Snader," he said, "if you're kidnaping us, you made a mistake. Nobody on Earth will pay ransom for us."

Snader seemed amused. "You are foolish fellow. Silly talk about ransom. You in different time now."

"When does this gag stop?" Jeff demanded irritably. "You haven't fooled us. We're still in 1957."

"You are? Look around."

Jeff looked at the street again. He secretly admitted to himself that these were different trees and houses than he remembered. Even the telephone poles and street lights seemed peculiar, vaguely foreign-looking. It must be an elaborate practical joke. Snader had probably ushered them into one house, then through a tunnel and out another house.

"Get in," Snader said curtly.

Jeff decided to go along with the hoax or whatever it was. He could see no serious risk. He helped Ann into the back seat and sat beside her. Snader slammed the door and slid into the driver's seat. He started the engine with a roar and they rocketed away from the curb, narrowly missing another car.

Jeff yelled, "Easy, man! Look where you're going!"

Snader guffawed. "Tonight, you look where you are going."

Ann clung to Jeff. "Did you notice the house we came out of?"

"What about it?"

"It looked as though they were afraid people might try to break in. There were bars at the windows."

"Lots of houses are built that way, honey. Let's see, where are we?" He glanced at house numbers. "This is the 800 block. Remember that. And the street--" He peered up at a sign as they whirled around a corner. "The street is Green Thru-Way. I never heard of a street like that."

III

They were headed back toward what should have been the boulevard. The car zoomed through a cloverleaf turn and up onto a broad freeway. Jeff knew for certain there was no freeway there in 1957--nor in any earlier year. But on the horizon, he could see the familiar dark bulk of the mountains. The whole line of moonlit ridges was the same as always.

"Ann," he said slowly, "I think this is for real. Somehow I guess we escaped from 1957. We've been transported in time."

She squeezed his arm. "If I'm dreaming, don't wake me! I was scared a minute ago. But now, oh, boy!"

"Likewise. But I still wonder what Snader's angle is." He leaned forward and tapped the driver on his meaty shoulder. "You brought us into the future instead of the past, didn't you?"

It was hard to know whether Snader was sleepy or just bored, but he shrugged briefly to show there was no reply coming. Then he yawned.

Jeff smiled tightly. "I guess we'll find out in good time. Let's sit back and enjoy the strangest ride of our lives."

As the limousine swept along through the traffic, there were plenty of big signs for turn-offs, but none gave any hint where they were. The names were unfamiliar. Even the language seemed grotesque. "Rite Channel for Creepers," he read. "Yaw for Torrey Rushway" flared at him

from a fork in the freeway.

"This can't be the future," Ann said. "This limousine is almost new, but it doesn't even have an automatic gear shift--"

She broke off as the car shot down a ramp off the freeway and pulled up in front of an apartment house. Just beyond was a big shopping center, ablaze with lights and swarming with shoppers. Jeff did not recognize it, in spite of his familiarity with the city.

Snader bounded out, pulled open the rear door and jerked his head in a commanding gesture. But Jeff did not get out. He told Snader, "Let's have some answers before we go any further."

Snader gave him a hard grin. "You hear everything upstairs."

The building appeared harmless enough. Jeff looked thoughtfully at Ann.

She said, "It's just an apartment house. We've come this far. Might as well go in and see what's there."

Snader led them in, up to the sixth floor in an elevator and along a corridor with heavy carpets and soft gold lights. He knocked on a door.

* * * * *

A tall, silver-haired, important-looking man opened it and greeted them heartily.

"Solid man, Greet!" he exclaimed. "You're a real scratcher! And is this our sharp?" He gave Jeff a friendly but appraising look.

"Just what you order," Snader said proudly. "His name--Jeff Elliott. Fine sharp. Best in his circuit. He brings his lifemate, too. Ann Elliott."

The old man rubbed his smooth hands together. "Prime! I wish joy," he said to Ann and Jeff. "I'm Septo Kersey. Come in. Bullen's waiting."

He led them into a spacious drawing room with great windows looking out on the lights of the city. There was a leather chair in a corner, and in it sat a heavy man with a grim mouth. He made no move, but grunted a perfunctory "Wish joy" when Kersey introduced them. His cold eyes studied Jeff while Kersey seated them in big chairs.

Snader did not sit down, however. "No need for me now," he said, and moved toward the door with a mocking wave at Ann.

Bullen nodded. "You get the rest of your pay when Elliott proves out."

"Here, wait a minute!" Jeff called. But Snader was gone.

"Sit still," Bullen growled to Jeff. "You understand radioptics?"

The blood went to Jeff's head. "My business is television, if that's what you mean. What's this about?"

"Tell him, Kersey," the big man said, and stared out the window.

Kersey began, "You understand, I think, that you have come back in time. About six years back."

"That's a matter of opinion, but go on."

"I am general manager of Continental Radioptic Combine, owned by Mr. Dumont Bullen." He nodded toward the big man. "Chromatics have not yet been developed here in connection with radioptics. They are well understood in your time, are they not?"

"What's chromatics? Color television?"

"Exactly. You are an expert in--ah--colored television, I think."

Jeff nodded. "So what?"

The old man beamed at him. "You are here to work for our company. You will enable us to be first with chromatics in this time wave."

Jeff stood up. "Don't tell me who I'll work for."

* * * * *

Bullen slapped a big fist on the arm of his chair. "No fog about this! You're bought and paid for, Elliott! You'll get a fair labor contract, but you do what I say!"

"Why, the man thinks he owns you." Ann laughed shakily.

"You'll find my barmen know their law," Bullen said. "This isn't the way I like to recruit. But it was only way to get a man with your knowledge."

Kersey said politely, "You are here illegally, with no immigrate permit or citizen file. Therefore you cannot get work. But Mr. Bullen has taken an interest in your trouble. Through his influence, you can make a living. We even set aside an apartment in this building for you to live in. You are really very luxe, do you see?"

Jeff's legs felt weak. These highbinders seemed brutally confident. He wondered how he and Ann would find their way home through the strange streets. But he put on a bold front.

"I don't believe your line about time travel and I don't plan to work for you," he said. "My wife and I are walking out right now. Try and stop us, legally or any other way."

Kersey's smooth old face turned hard. But, unexpectedly, Bullen chuckled deep in his throat. "Good pop and bang. Like to see it. Go on, walk out. You hang in trouble, call up here--Butterfly 9, ask for Bullen. Whole exchange us. I'll meet you here about eleven tomorrow pre-noon."

"Don't hold your breath. Let's go, Ann."

When they were on the sidewalk, Ann took a deep breath. "We made it. For a minute, I thought there'd be a brawl. Why did they let us go?"

"No telling. Maybe they're harmless lunatics--or practical jokers." He looked over his shoulder as they walked down the street, but there was no sign of pursuit. "It's a long time since supper."

* * * * *

Her hand was cold in his and her face was white. To take her mind off their problem, he ambled toward the lighted shop windows.

"Look at that sign," he said, pointing to a poster over a display of neckties. "'Sleek neck-sashes, only a Dick and a dollop!' How do they expect to sell stuff with that crazy lingo?"

"It's jive talk. They must cater to the high-school crowd." Ann glanced nervously at the strolling people around them. "Jeff, where

are we? This isn't any part of the city I've ever seen. It doesn't even look much like America." Her voice rose. "The way the women are dressed--it's not old-fashioned, just different."

"Baby, don't be scared. This is an adventure. Let's have fun." He pressed her hand soothingly and pulled her toward a lunch counter.

If the haberdasher's sign was jive, the restaurant spoke the same jargon. The signs on the wall and the bill of fare were baffling. Jeff pondered the list of beef shingles, scorchers, smack sticks and fruit chills, until he noticed that a couple at the counter were eating what clearly were hamburgers--though the "buns" looked more like tortillas.

Jeff jerked his thumb at them and told the waitress, "Two, please."

When the sandwiches arrived, they were ordinary enough. He and Ann ate in silence. A feeling of foreboding hung over them.

When they finished, the clerk gave him a check marked 1/20. Jeff looked at it thoughtfully, shrugged and handed it to the cashier with two dollar bills.

The man at the desk glanced at them and laughed. "Stage money, eh?"

"No, that's good money," Jeff assured him with a rather hollow smile. "They're just new bills, that's all."

The cashier picked one up and looked at it curiously. "I'm afraid it's no good here," he said, and pushed it back.

The bottom dropped out of Jeff's stomach. "What kind of money do you want? This is all I have."

The cashier's smile faded. He caught the eye of a man in uniform on one of the stools. The uniform was dark green, but the man acted like a policeman. He loomed up beside Jeff.

"What's the rasper?" he demanded. Other customers, waiting to pay their checks, eyed Jeff curiously.

"I guess I'm in trouble," Jeff told him. "I'm a stranger here and I got something to eat under the impression that my money was legal tender. Do you know where I can exchange it?"

* * * * *

The officer picked up the dollar bill and fingered it with evident interest. He turned it over and studied the printing. "United States of America," he read aloud. "What are those?"

"It's the name of the country I come from," Jeff said carefully. "I--uh--got on the wrong train, apparently, and must have come further than I thought. What's the name of this place?"

"This is Costa, West Goodland, in the Continental Federation. Say, you must come from an umpty remote part of the world if you don't know about this country." His eyes narrowed. "Where'd you learn to speak Federal, if you come from so far?"

Jeff said helplessly, "I can't explain, if you don't know about the United States. Listen, can you take me to a bank, or some place where they know about foreign exchange?"

The policeman scowled. "How'd you get into this country, anyway? You got immigrate clearance?"

An angry muttering started among the bystanders.

The policeman made up his mind. "You come with me."

At the police station, Jeff put his elbows dejectedly on the high counter while the policeman talked to an officer in charge. Some men whom Jeff took for reporters got up from a table and eased over to listen.

"I don't know whether to charge them with fakemake, bumsy, peekage or lunate," the policeman said as he finished.

His superior gave Jeff a long puzzled stare.

Jeff sighed. "I know it sounds impossible, but a man brought me in something he claimed was a time traveler. You speak the same language I do--more or less--but everything else is kind of unfamiliar. I belong in the United States, a country in North America. I can't believe I'm so far in the future that the United States has been forgotten."

There ensued a long, confused, inconclusive interrogation.

The man behind the desk asked questions which seemed stupid to Jeff and got answers which probably seemed stupid to him.

The reporters quizzed Jeff gleefully. "Come out, what are you advertising?" they kept asking. "Who got you up to this?"

The police puzzled over his driver's license and the other cards in his wallet. They asked repeatedly about the lack of a "Work License," which Jeff took to be some sort of union card. Evidently there was grave doubt that he had any legal right to be in the country.

In the end, Jeff and Ann were locked in separate cells for the night. Jeff groaned and pounded the bars as he thought of his wife, imprisoned and alone in a smelly jail. After hours of pacing the cell, he lay down in the cot and reached automatically for his silver pillbox. Then he hesitated.

In past weeks, his insomnia had grown worse and worse, so that lately he had begun taking stronger pills. After a longing glance at the big red and yellow capsules, he put the box away. Whatever tomorrow brought, it wouldn't find him slow and drowsy.

IV

He passed a wakeful night. In the early morning, he looked up to see a little man with a briefcase at his cell door.

"Wish joy, Mr. Elliott," the man said coolly. "I am one of Mr. Bullen's barmen. You know, represent at law? He sent me to arrange your release, if you are ready to be reasonable."

Jeff lay there and put his hands behind his head. "I doubt if I'm ready. I'm comfortable here. By the way, how did you know where I was?"

"No problem. When we read in this morning's newspapers about a man claiming to be a time traveler, we knew."

"All right. Now start explaining. Until I understand where I am, Bullen isn't getting me out of here."

The lawyer smiled and sat down. "Mr. Kersey told you yesterday--you've gone back six years. But you'll need some mental gymnastics to understand. Time is a dimension, not a stream of events like a movie

film. A film never changes. Space does--and time does. For example, if a movie showed a burning house at Sixth and Main, would you expect to find a house burning whenever you returned to that corner?"

"You mean to say that if I went back to 1865, I wouldn't find the Civil War was over and Lincoln had been assassinated?"

"If you go back to the time you call 1865--which is most easily done--you will find that the people there know nothing of a Lincoln or that war."

Jeff looked blank. "What are they doing then?"

The little man spread his hands. "What are the people doing now at Sixth and Main? Certainly not the same things they were doing the day of the fire. We're talking about a dimension, not an event. Don't you grasp the difference between the two?"

"Nope. To me, 1865 means the end of the Civil War. How else can you speak of a point in time except by the events that happened then?"

"Well, if you go to a place in three-dimensional space--say, a lake in the mountains--how do you identify that place? By looking for landmarks. It doesn't matter that an eagle is soaring over a mountain peak. That's only an event. The peak is the landmark. You follow me?"

"So far. Keep talking."

* * * * *

The little man looked pleased. "Very well. In the fourth dimension--which is time--you do the same thing. You look around to see what is visible where you are. My contemporaries can see that freedom is unnecessary, that time travel is practical. Your people have not reached that place in time yet. But yours can see the technical facts about color television. Those facts are not visible yet to anyone here."

"You mean that these inventions--"

"Oh, no, no, no, Mr. Elliott," the little man said indignantly. "Don't call them inventions. There are no inventions. None. There are only truths--scientific principles waiting through eternity for someone to discover them."

"I must be dense, but--"

"Did your Columbus invent America? Did someone invent fire? The possibility of time travel, of color television, of any phase of social progress--these are facts. They stand up in the time dimension like mountains. Waves of humanity meander through the time dimension like caravans of immigrants crossing a continent. The first man in any wave to see the mountain peak claims that he 'invented' it. Soon it is clearly visible to everyone. While the people of my wave know of time travel, there are human caravans, following us many years back in time, just now discovering steam."

"Then the reason your people won't accept my money--"

"Yah." The little lawyer nodded. "Your money is an outgrowth of your history. It bears the name your people gave to the society they built--the United States. This has no meaning to a different wave of humanity, with a different history. These people here have reached this point in time six years behind the humanity you traveled with."

"Can I get back to my own time, my own wave of humanity?"

"Not unless you know how." The lawyer grinned. "To be perfectly frank, Mr. Elliott, there is no hope of your going back. Either work for Bullen or live out your life in a mental institution. No one else will give you work and no one will believe your story."

Jeff clamped his teeth. If a crook like Snader could move freely back and forth in time, there must be a way for Jeff to do it. Meanwhile, he would pretend to be a humble and obedient servant.

"Okay," he said to the lawyer. "I'm convinced. Get me out."

"Snader is waiting with a car," the man said. "He'll meet you and your wife outside. I'll free her at once, then go about my business."

* * * * *

Snader was standing beside the limousine. He looked Ann up and down. "I like you, little lady. Soon I know you better."

Jeff felt his temper rise. "You sure fooled us, didn't you, Snader?"

"I warned you. There was risk."

Ann's voice was steady. "Jeff, where are we going now?"

"Back to Bullen. I understand the setup now. Maybe we'd better play ball with him."

"Did you find out what place this is?"

"Yes--well, sort of. Here's a rough rundown. Incredible as it seems, we really are in a past time period--different from our own past. This period doesn't have color TV yet. Bullen wants to be first on the market with it. So he sent our pal Greet Snader here to pick a man in future time who had already mastered TV and sell him to Bullen as a captive scientist. I imagine Snader raids the future for many experts."

Snader stepped up to him with a dangerous smile. "All right, big wit. Tell me my business. Tell me all about it."

"You heard me. You're in the slave business." The blood throbbed in Jeff's head.

"You don't like?" Snader's scarred face looked fierce and gloating. "Maybe you shovel coal from now. Or wipe floors."

Jeff saw policemen watching from the jail entrance. He clamped his mouth shut.

"Don't be excitable or you get hurt," Snader advised. "We own you. We gave you a break. Remember that, wise boy. You ready now?"

Jeff nodded silently.

Snader playfully twisted Jeff's ear and shoved him into the limousine. "Don't tell me anything. Then I don't hurt you."

V

Between Snader and Ann in the front seat, Jeff held Ann's hand and winked encouragingly at her.

"Snader, I guess you're right," he said. "This is a good deal for me. I was sort of washed up in my own time."

"Now you smart," Snader said. "Your little lady? She smart, too?"

"Yep. By the way, how come you got us out so early? It's only nine o'clock. Bullen said he'd expect me at eleven."

"We go to time station first," Snader explained shortly. "I pick up documents there. Breakfast there."

"Good," Jeff said cheerfully. A plan was taking shape in his mind. "All I'm worried about is my speed-up pills. Can I get some at the station? I'm almost out." He pressed Ann's knee warningly.

"Speed-up pills?" Snader looked suspicious--but then, he always did. "What you mean?"

"Don't you have speed-up tablets?" Jeff put surprise in his voice. "Stuff to activate the half of the brain that normally doesn't work. You must have them."

"What they look like?"

Jeff fumbled for his silver pillbox. "They're the big red and yellow capsules." He handed the box to Snader. "Don't spill them. I only have three left. Where can I get more like those? I won't be nearly as good without them."

Keeping one hand on the wheel, Snader glanced down. The box had a jumble of black vitamin pills and red and yellow sleeping tablets.

"You say these big ones help brain?" he asked warily.

"They speed up the reflexes--they make everything seem clear and easy. Please give them back before you spill them."

Snader thumbed the red and yellow capsules out and handed the box back without them. "I keep these." He moved his head craftily to watch Jeff's face in the mirror.

Jeff was ready. He registered rage and fear. "Gimme those!" he shouted. "I need them."

Snader laughed. "Don't tell me orders. Easy now. You want to wreck car?"

"I'll wreck us all if you don't give those back!" He grabbed Snader's

hand.

Ann screamed as the car swerved, and horns blared from behind. Snader clapped the capsules into his mouth and gripped the wheel with both hands.

"I take what I want," he said, gulping down the pills. "You give trouble, I turn you over to police."

* * * * *

Jeff slumped down with a groan and buried his face in his hands to hide a grin. It had worked. How long would the nembutal take to hit Snader? It might act too fast. Jeff wondered what he could do then.

Luckily, there was only a short distance to go. Even so, the car was weaving as they whirled off the express road into Green Thru-Way. When they pulled up in front of the barred house, Snader tumbled out and lurched up the walk without a glance at his prisoners.

Jeff and Ann followed, and Jeff stood close behind while Snader fumbled inside his shirt for the key. When he found it and reached toward the door, his knees buckled and Jeff caught him.

"The key, Ann," Jeff whispered. "Pull the cord over his head and unlock the door."

Ann clawed at it while Jeff supported the weight of Snader's body. In a moment, she had the door open and they were inside.

The old housekeeper bustled in as Jeff half-dragged and half-lifted Snader across the living room.

"It's nothing serious," Jeff told her calmly. "He often has these attacks. He'll be all right in a few minutes, and then I'll start him off home."

"Oh, the poor man," she clucked. "Such a ghast. Can I get you anything?"

"Get us some hot water, mixed with mustard and soda," Jeff said, hoping this would keep her busy for several minutes. She hurried away.

Ann unlocked the door into the inner room and Jeff lugged the slave trader inside. On the two screens, the endless chair-lined corridors

still fled toward them.

When the door clicked shut, Jeff let Snader slide to the floor. Swiftly he went through the man's pockets and felt in the lining of his clothes for hidden documents. Papers, wallet, car-keys, a big stiff card that seemed to be some kind of passport--Jeff stuffed everything into his own pockets.

"Hurry, Jeff," Ann begged. "Why waste time emptying his pockets?"

"So he can't come back and bother us," Jeff said. "I'm sending this joker on a one-way ride. He'll never be able to prove to the authorities who he is."

* * * * *

Several pictures hung on the wall. Jeff jerked them down and used the wire to tie Snader's feet and wrists. He tore some draperies to bind him tighter. When the body was trussed like a turkey, Jeff heaved it to his shoulder. With one lunge, he threw the unconscious man straight into the screen. Snader vanished.

"What happens when he wakes up?" Ann shakily wanted to know.

Jeff dusted himself off. "He's headed to the end of the line," he said harshly. "Remember? He told us about it. Without credentials, he'll land in the convict gang, down around the year 600 A.D. That's a bad time on this continent. Men who work there don't return--they help build back the time groove."

Ann smiled triumphantly. "Good for you! He deserved it. Imagine running a commercial kidnapping enterprise! And now we can ride home, can't we?"

Jeff, beginning to enjoy himself, shook his head. "Not just yet. First I've got a date with Mr. Bullen."

When they rapped on Bullen's door, Kersey welcomed them with an amused smile.

"We thought you would be back," he purred. "Where is Snader?"

Jeff brushed past him to the drawing room, where Bullen sat by the window.

"I've decided to help you, Bullen," Jeff said.

Bullen nodded his big head. "Naturally."

"But I name my own price. What do you pay Kersey?"

Bullen looked up with a grim smile. "Fifty thousand a year. I wonder now if he worths it."

"What's that? Dollars?"

"We call them fiscals. Probably somehow much the same. Why?"

"Listen, Bullen. If I help introduce color TV, there'll be big money in it. I won't be a hog. You pay me forty thousand a year until we go into production. Then we'll make a new deal, giving me a royalty on sales."

Kersey's face was scarlet. "You young greenshoot! Who do you think you are? You'll work for nothing, if we say so."

"Guess again," Jeff said. "Your slave trader won't be bringing any more engineers for you. So you take me at my price--or nobody."

The big man laughed. "You got rid of Snader, eh? Well, well. He was a rogue. I thought he would run into trouble soon or late."

* * * * *

Kersey swore, but Bullen seemed to grasp the situation and waved him to silence. "I like your fire, young man. With chromatics, we'll make millions, so you're worth forty thousand plus royalties. Am I true in thinking you won't want the apartment I reserved for you?"

"Right. We'll retain our home in my own time. I'll commute to work here every morning--it's quicker than commuting to the city in my own time."

"In your thorough way," Kersey said sarcastically, "you have doubtless figured out how you can spend our money back in your time."

"I've thought about it," Jeff agreed. "There will be something I can convert it into and carry back. Diamonds, maybe."

Bullen laughed again. "You're solid, my boy. Get his work papers ready,

Kersey. These young people want to get home. I'll take Jeff to the factory when he comes workward in the morning."

Jeff stood up. "See you tomorrow, Bullen. Come on, Ann. We're going home--home to our own time."

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THE RABBIT: HABITS AND APPEARANCE.

Project Gutenberg's An Introduction to Nature-study, by Ernest Stenhouse

1. =The habits of the wild rabbit.=—In what places have you known wild rabbits to have a _warren_? In what kind of ground is a rabbit warren generally found? How can you recognise it? Are all the holes of the warren of similar size, or can you distinguish between main entrances and "bolt-holes"? Look for smooth paths, perhaps nine inches wide, which lead to the main entrances and intersect each other, so as to form "runs." Watch the animals feeding and playing; to do this successfully it will be necessary to keep very still and silent; avoid walking on the runs. What do the rabbits eat? Do they walk, or hop? How do they run? Notice how conspicuous is the white tail of a running rabbit. In June look for a nest of young rabbits. The position of such a nest may often be recognised, when the doe is away from home, by a smooth patch of earth with which she has covered up the hole. Dig up this very carefully and notice how the nest is lined. Examine the young ones without hurting them, and then cover them up again.

What is the _colour_ of a wild rabbit? Does the colour render the animal less conspicuous? Are tame rabbits so often of this colour? Why not? Watch a tame rabbit, noticing especially the movements of its nostrils, whiskers, and ears, and its method of feeding. Try to see how it gnaws the bars of its hutch.

2. =Fur.=—Examine a dead rabbit. With what is the skin covered? What are the differences between the fur of a rabbit, the hair of a dog, and the wool of a sheep? Is fur curly? Does it lie flat on the skin? Does it consist of different sizes of hair—short, fine hairs and long, thicker ones? What other animals do you know which have fur?

3. =The head.=—(_a_) _The whiskers._—On what parts of the head are the longest hairs found? How do these differ, apart from length, from ordinary hairs? What other common animals have whiskers? Do such animals often make their way through narrow passages? What do you suppose is the use of the whiskers?

(b) The skull.—Feel the bones of the head through the skin, and make out the rounded brain-case, the ridge above and the arch below each eye, and the positions of the jaws.

(c) The external ears.—Examine the large ear-flaps. Notice that the upper parts are thin and almost transparent, and that the lower parts are gristly and lead into the interior of the head.

(d) The eyes.—Notice that the eyes are at the sides of the head. Is this position an advantage to the rabbit? Examine, in each eye, the upper and lower lids; and also, in the angle of the eye next the nose, the third eyelid—a fold of white skin. Take hold of this fold with the forceps and see that it is easily pulled over the eyeball. Look in a mirror and see the little fleshy body which occupies a similar position in your own eye; this corresponds to the rabbit's third eyelid. In the visible part of the rabbit's eyeball notice the round dark pupil in the middle (contrast the pupil of a cat's eye); the coloured ring (the iris) surrounding the pupil; and the "white" (called the sclerotic) surrounding the iris.

(e) The lips and nostrils.—Notice how the upper lip is split in the middle line, so as to show the front teeth. What is the use of the split? Notice the grooves passing from the upper lip to the nostrils.

(f) The inside of the mouth.—Open the rabbit's mouth and notice:

(i) The two gnawing or incisor teeth in the lower jaw, and the pair of strongly-grooved incisors which are so conspicuous in the upper jaw. Just behind the large, upper incisors two smaller incisors may be felt with the finger. Separated by a wide space from the incisors are the grinding teeth—six on each side in the upper jaw, and five on each side in the lower jaw.

(ii) The tongue, lying between the halves of the lower jaw.

(iii) The hard ridges running across the fore half of the roof of the mouth.

(iv) The hairiness of the inside of each cheek, between the incisor and grinding teeth.

4. =The neck.=—Notice how the neck enables the head to be turned freely in various directions without the body being moved. Feel through the

skin and identify:

(_a_) In front of the neck, the _trachea_ or windpipe, with the _larynx_ or “voice box” at its upper end between the halves of the lower jaw.

(_b_) The bones of the neck-part of the _spine_.

5. =The trunk.=—Feel through the skin and make out the _spine_, the _breast-bone_, and the curved _ribs_ which connect these. The spine, breast-bone, and ribs together form a bony cage which encloses the fore-part (the _thorax_) of the body. The hinder and larger part of the body (the _abdomen_) is not protected by ribs, but the bones of the spine are largest and stoutest in this part of the body.

6. =The limbs.=—How many limbs has the rabbit? Which pair is the longer? Is the difference in length an assistance in leaping? Make out the main divisions of each limb, and, by feeling through the skin, the manner of attachment of its bones to the bones of the body (Fig. 161).

7. =The tail.=—Notice the length, shape, position, and colour of the tail. The chain of bones inside it is a prolongation of the spine.

=Methods of studying animals.=—In studying animals, methods similar in principle to those described in previous chapters for plants should be employed. A real knowledge of the =habits= of animals can only be obtained by watching them as closely as possible in their natural surroundings. It is often very difficult to get sufficiently close to shy animals to see them distinctly without causing alarm, and a good field-glass is a valuable help in such cases. A great deal of first-hand knowledge of wild life can, however, be gained without such aids if the student will learn to move quietly and silently, and to remain motionless as soon as he is in a good position for observation. The books of such masters of woodcraft as Richard Jefferies, William J. Long, Ernest Thompson Seton, and W. H. Hudson give charming descriptions of the methods of tracking and studying wild animals, and should be carefully read by every field-naturalist. Observations made in the field should be at once recorded, with the date, in a note book.

Many animals can be kept for some time, without cruelty, in confinement; and a more intimate knowledge of certain of their habits can be thus obtained. The practice of keeping =pets= is, however, to be encouraged only when every possible care is taken to secure the comfort of the captives.

To understand the internal structure of an animal, =dissection= is necessary. This consists in exposing and separating the internal organs of the dead animal from each other, in order to notice their mutual relation. A careful outline drawing of every dissection should be made and preserved. The student should make it a rule never to kill any animal unless for some useful purpose, and then to do so in the quickest and most painless manner.

=The habits of the rabbit.=—Wild rabbits live in =burrows= or underground passages which they excavate, by means of their strong feet, in the soil of sandbanks, fields, woods, etc. The animals are sociable, and the burrows belonging to any one community are collectively known as a =warren=. The passages of the warren communicate with the outside world by means of openings, some of which are in common use, while others seem to be used mainly as “bolt-holes” in cases of sudden alarm. A rabbit which is bolting to its burrow exposes the white underside of its tail, and thus acts as a danger signal and guide to its fellows. When a rabbit is startled, or puzzled by seeing some unusual object, it generally thumps the ground smartly with its long hind-foot; other rabbits in the neighbourhood are thereby warned.

[Illustration: FIG. 159.—Rabbits.]

It is common to find, outside a rabbit warren, a number of intersecting paths, perhaps nine inches wide, and worn smooth by the patter of little feet. These are the highways, or “runs,” which lead from the holes of the warren to the various feeding-grounds.

Rabbits breed very rapidly; it has been estimated that in five years a single pair might have about a million descendants, were it not for the countless mishaps to which rabbits are exposed. The young are born and suckled in a special shallow burrow, which the doe excavates and lines with dry leaves, fur, etc. When she leaves the nest for any purpose she covers up the entrance with soil.

The proportions of the parts of the body of a very young rabbit are markedly different from those of the adult. The head is relatively larger, the tail longer, and the ears shorter; while the hind limbs and fore limbs are of almost equal length. During the first six months of its life the animal gradually takes on the proportions of the adult—with small head, long ears, large hind legs with long feet, and small, upwardly-turned tail.

A rabbit is able to stand upright on its hind legs, and to maintain itself in this position for a considerable time. It thus obtains a wider view and a greater choice of food.

The great difference in the length of the fore and hind legs gives the animal a characteristic gait. "In a freely moving rabbit," says Jefferies, "both fore-feet stop when the hinder come up—one hinder foot slightly behind the other, and rather wide apart." Rabbits are exclusively vegetarian feeders, living on green herbs and on the tender shoots and bark of shrubs and young trees.

=The external characters of the rabbit.=—The outside of the rabbit's body is almost entirely covered with =fur=. This consists of two kinds of hair—coarse and fine. The coarser hairs are fewer in number and longer than the fine ones, which they protect from wet. The fine hairs are extremely closely-set, and stand straight out from the skin. In a seal-skin coat only the short hairs of the fur are to be found; the longer hairs have been removed by the dressing process. The great warmth of furs is due to the air which is entangled between the fine, close hairs. It is generally the case that fur-bearing animals are exposed to either mud or wet by their method of life; in spite of this fact, while the hair of a dog soon becomes wetted by rain, and the wool of a sheep retains a great deal of dirt, furred animals are noted for keeping their coats clean and dry.

The longest hairs of the rabbit are the stiff =whiskers= which stand out from the upper lip, the cheeks, and above the eyes. They are extremely sensitive to touch, and are of great assistance to the animal in finding its way through the dark burrows.

The =colour= of the wild rabbit is greyish brown, except on the belly and under the tail, where it is white. This colour harmonises well with the surroundings, and renders the animal much less noticeable. Wild rabbits are exposed to so many enemies, that individuals which happen to be born with conspicuously coloured fur have generally but a poor chance of surviving and leaving offspring to inherit their disadvantages. There is thus in each generation a =natural selection= of the animals which are best protected, by their colour, from observation. Among tame rabbits, on the other hand, =protective colouration= is of very little importance, and one variation of colour is as likely as another to be transmitted by =heredity= to the next generation.

=The regions of the body.=—For convenience and precision in describing animals it is customary to use the words =anterior= and =posterior= to indicate the fore, or head, end, and the hind, or tail, end respectively. The belly-surface is said to be =ventral=, and the back =dorsal=.

The body of a rabbit obviously consists of head, trunk, a short tail, and four limbs. The general arrangement of the bony framework, or =skeleton=, (Fig. 161) which supports the softer parts may be felt through the skin. The skeleton consists of (1) the _skull_; (2) the spine or _vertebral column_ (generally spoken of as the backbone), placed dorsally, and reaching from the anterior end of the neck into the tail; (3) the ventral _sternum_ or breast-bone, which is connected with the vertebral column by means of curved _ribs_; (4) the bones of the two pairs of limbs, with the shoulder-and hip-bones to which they are attached. The bones will be studied in more detail in the next chapter.

The trunk is divided into two regions—an anterior =thorax=, or chest, (enclosed in the bony cage formed by the ribs, sternum, and the adjoining part of the vertebral column), and a posterior =abdomen=. The two cavities are divided from each other by a fleshy partition called the _diaphragm_.

=Organs of special sense.=—In addition to the sense of touch which is possessed by the whole surface of the body, the rabbit has organs which enable it to distinguish objects by sight, sounds, scents, and taste. Its sense of =smell= is so keen that, to be successful in snaring rabbits, “in walking to the spot selected for the snare it is best to avoid even stepping on the run, and while setting it up to stand back as far as convenient and lean forward. The grass that grows near must not be touched by the hand, which seems to impart a very strong scent. The stick that has been carried in the hand must not be allowed to fall across the run; and be careful that your handkerchief does not drop out of your pocket on or near it. If a bunch of grass grows very tall and requires parting, part it with the end (not the handle) of your stick.”[8]

The shape of the =ear-flaps=, which can be turned in different directions (Fig. 159), enables the rabbit to catch very slight sounds.

The =eyes= are placed on the _sides_ of the head, so that the animal has a wide field of view, and an enemy approaching from behind is not likely to be unnoticed. The eye of the rabbit is very similar in

structure to our own, but it possesses one useful adjunct which ours has lost, in the shape of a _third eyelid_—an opaque flap of skin which lies in the inner angle, and can be drawn over the eyeball at will. The little fleshy nodule in the corresponding position of the human eye is a rudiment of a similar structure.

=The rabbit a gnawing animal.=—Rabbits are much addicted to gnawing young trees for the sake of the bark and the softer juicy tissues between bark and wood. Even tame rabbits exhibit the same instinct by gnawing their wooden hutches, although these are of no use as food. The gnawing is done by the sharp teeth, called =incisors=, which are conspicuous in the middle of both upper and lower jaw. In the upper jaw two incisors (which are so deeply grooved that they look like four) are visible even when the mouth is closed, owing to the split in the middle of the upper lip. The hardest part of the tooth (a substance called _enamel_) is at the front. Behind this the tooth is composed of a softer, bony material called _dentine_; and the back of the tooth consists of still softer dentine. The result of these differences in the composition of the various parts of the tooth is that the gnawing of hard substances wears away the back of the tooth most, the middle part next, and the front least of all; and thus a sharp chisel-edge is always maintained. Moreover, _the teeth of the rabbit never stop growing_, so that they never become appreciably shorter through use. Immediately behind the two visible incisors of the upper jaw, another and smaller pair can be felt by the finger; the enamel-faces of these are directed backwards towards the cavity of the mouth. The softer and more easily worn faces of the two pairs of upper incisors are thus in contact, and are continually worn down to form a groove. Into this groove the two incisors of the lower jaw bite. The incisor teeth stand well out from the jaws, and the split upper lip can be drawn back, so that the lips are not injured by gnawing. In the hinder part of the mouth, where the chewing, or =mastication=, of the food takes place, are six flatter but cross-ridged =grinding teeth= on each side of the upper jaw, and five on each side of the lower jaw. The insides of the cheeks are protected from sharp splinters of wood by a patch of =hair= on each side, which extends from the region of the incisors to the grinding teeth behind. The roof of the mouth is protected by hard cross-ridges, and the tongue by tough skin.

=Rodents.=—Rabbits and hares, rats and mice, and squirrels are said to be rodents (Lat. _rodo_, I gnaw), as they not only agree in the gnawing habit, but also in other very important respects.

=Mammals.=—Rodents, and all other animals which suckle their young,

are included by naturalists in the class Mammalia. These animals agree further in breathing air, in having warm blood, and in being more or less completely covered with hair.

=Vertebrates.=—Mammals, birds, reptiles, amphibians, and fishes are grouped together to form the sub-kingdom Vertebrata. They are given this name because they all possess a spinal, or vertebral, column (which usually consists largely of a chain of bones), running below the dorsal surface (p. 217) of the body, from neck to tail.

=The position of the rabbit in the animal kingdom.=—It is clear from the above that the rabbit is, in the first place, a =vertebrate= animal; it belongs, secondly, to the _mammalian_ class of vertebrates, and thirdly, to the _rodent_ -order of mammals.

EXERCISES ON CHAPTER XII.

1. In what respects does the hind-foot of a rabbit differ from the fore-foot? What is the use of the difference?
2. Describe the way in which a rabbit runs. What precautions does it take when feeding in an open place? (1901)
3. Make observations of the habits and external characters of hares, and compare them, point for point, with those of rabbits.
4. Describe the inside of a rabbit's mouth, and explain the advantages of any peculiar features to be seen in it.
5. Mention the two chief constituents of a rabbit's tooth. Describe by what means the edges of a rabbit's incisor teeth are kept sharp.
6. Make a list of all the vertebrate animals with which you are acquainted. Why are they called vertebrates?
7. By what external characters would you recognise that an animal was a mammal?

FOOTNOTE:

[8] Jefferies, _The Amateur Poacher_ (Smith, Elder & Co.).

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Rabbits Have LONG Ears

BY LAWRENCE F. WILLARD

_The computer classified it
"rabbit" and Montresig was not
one to argue, long ears or not!_

[Transcriber's Note: This Project Gutenberg etext was produced from
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Commander Losure gave orders to his navigator to bring the ship in on the satellite out of sight of the prying telescopes which no doubt existed on such an invitingly green planet. He was a cautious man and didn't intend to lose any more crew members if he could help it. He could tell by the unusually poor handling of the ship that the crew was still demoralized from the brush with the high I.Q. slugs on that last planet which they had approached so directly. They'd lost three men in that scrap, one of them a highly-valued anthropologist. There were only two more of those left in the freeze locker. Too bad it couldn't have been a radio operator, there were plenty of those on ice.

The Commander's thoughts were interrupted by his second officer who entered without the customary military burp.

"I'll forgive you this time, Montresig," said the Commander, "but we can't relax regulations now, can we. Anything new to report on this planet?"

"No, Your Loftiness," said Montresig, after giving a belated burp, "there's nothing to add to what we already know, but then we've just come to rest on this clinker of a moon. I don't imagine, however, that we've located our long lost ancestors or our mythical home planet. There doesn't seem to be a race in this galaxy that walks upright on two good legs with two arms, two eyes, nose, mouth and other standard equipment."

"Could be we'll find one this time," said the Commander. "We know it's an oxygen planet, and that there are intelligent beings there, judging from the cities we can see and their use of radio."

"Maybe," grumbled Montresig, "but they won't be men. If they're not slugs they'll be talking fish or intellectual spiders, or something equally repulsive. And I can tell you one thing, whatever we find, if it has brains it will want to fight."

"Now Montresig, don't be bitter. We've only examined a couple hundred planets. There are many more and you know we'll have to take a look at as many as we can. I tell you, however, we won't take any more chances. Unless we find out they're pretty much like us we won't go near the damn planet."

"How do you propose to find that out, Your Loftiness? We can't see anything that small by telescope, we haven't learned much so far by listening to them, and it's pretty dangerous business using the dredge...."

"Ah, my dear Montresig, the crux of the matter is that we can tell about them, I believe, from listening to them. Judging from the reports I got from Communications, this is the talkingest planet in the galaxy. They are utilizing the entire radio spectrum we know and, I suspect, some portions of it we don't know. All they do is talk. There must be millions of individuals on that planet jabbering in a dozen different languages. Our language technicians have decoded two of the major tongues already and have fed the information to the main computer. All radio signals in those languages are now being fed directly to the computer and the information is being classified and cross-referenced."

Montresig's furry countenance brightened. "Then we won't have to send down the dredge?"

"I hope not, Montresig, I do not like to bring strange life forms aboard the ship. Remember planet 187 in the Dghorzid system?"

Montresig shuddered. "I'll never forget. When that monster materialized in the hold I snapped on the stasis field and it had no effect. I tried every last trick in the bag including seven kinds of poison gas. Luckily the dredge operator was able to catch him and throw him back where he came from but the hold was a shambles and two men had to have extensive repair work."

"Well," said the Commander, "I don't like the dredge at all, but I suppose it's better than landing and having to do battle with slugs. I swear I was certain there was no intelligent life on that planet. By the way, I'm having an anthropologist thawed out now, that leaves only one more in the freeze locker and we can't operate without one. Take care nothing happens to him, Montresig."

Commander Losure made the sign of dismissal and Montresig burped gracefully and withdrew. The Commander signaled communications. After a considerable delay a burp sounded from the speaker on the wall and a voice announced: "Troniff here. May I serve Your Loftiness?"

"Troniff," said the Commander, "the delay is inexcusable. Does the computer have its belly full yet?"

"Your Loftiness, the reference tapes are full, but the machine is unable to present a full picture of the dominant life form. It appears, however, that they are much like us in general body shape. Unfortunately, we can get no reference point from which to judge their size. They are exceedingly ferocious and blood thirsty, and apparently war among themselves continuously."

"I'm tempted to leave now," said the Commander. "I'll have to use the dredge, I suppose.... Are you sure it won't do some good to listen to their communications awhile longer?"

The speaker was silent for a moment, then Troniff spoke.

"I don't like to mention this, Your Loftiness, but my engineers have found several unidentified types of emission besides those carrying speech frequencies. They think that one particular type characterized by an extremely broad frequency range just might be transmission of visual images...."

"I don't believe it," said the Commander. "We've been trying to do that for hundreds of years without success and so far as we've been we've never found another race in the galaxy as far advanced technologically as ours. These people don't even have space flight."

"They have artificial satellites up," said Troniff, "We're monitoring signals from one, and from what I gather they're apt to have something up on this moon before long."

"Any chance of finding out how they transmit visual images--if they really do?"

"Not a chance," said Troniff. "My engineers can't even conceive of a device that could convert these signals into a picture."

"That's all, Troniff. Notify Montresig that he's to meet me immediately in the dredge room with the anthropologist and a dredge operator."

The commander sighed. What irony that the only truly peaceful race in the galaxy should be the only one to discover interstellar flight. For four thousand years the Kaar had had their ships and had colonized hundreds of planets until they had lost track of which one they started from. In all that time they had avoided planets with intelligent life, had never found any other ships in space. Now, thought the Commander, we have to go looking for trouble just to satisfy our curiosity as to where we started from.

Montresig introduced the newly-thawed anthropologist to him on the dredge room balcony and Commander Losure briefed him on the importance of his job.

"We don't believe this race has any connection with ours," said the Commander. "It's too savage. And yet, we haven't found another race as far advanced in science, nor one that appears to be so similar to ours. Our problem is to find out a little more about them, their physical size, whether it's safe to contact them, which I personally doubt."

"Is it your intention to bring back one of these intelligent beings with the dredge?" asked the anthropologist.

"You know better than that, or maybe you don't," said the Commander. "Anyway, you should know that it is against our code of ethics to cause harm to any intelligent being. That dredge is set to reject any living creature capable of a high order of thought and that control is sealed against our use. The idea is to bring back artifacts that might tell us something about the people of the planet... maybe they have a written language and have something that approximates our scrolls, maybe they have drawings. I'd especially like to snag one of the visual image receptors our communications engineers think they have."

"The dredge operator is ready," said Montresig. "The computer controls have been switched to this balcony and the stasis beam has been checked."

* * * * *

Commander Losure looked up at the dredge operator in his glassed-in booth high on the opposite wall of the hold. He gave a quick hand signal and transferred his attention to the floor of the vast hold below him. A shimmering mistiness began to form in the center of the floor. Commander Losure could feel the tension of his companions as they waited. It was a blind grab; the dredge operator had no way of knowing what would be scooped up at the end of his force beam. Slowly the mistiness grew more dense, darkening to an impenetrable cloud, and then vanished with an audible snap leaving a strange alien mechanism on the floor of the hold. It resembled a huge cylinder resting on tractor-like treads.

From the balcony the men scurrying across the floor seemed dwarfed by the object. Unheeding of any danger they swarmed over it, measuring, testing, amassing information to be fed to the computer.

"Holy Ghosts of My Departed Ancestors," gasped Montresig, "what is it?"

"You know as much about it as I do, my dear fellow," the Commander said. "As soon as the engineers get through poking at it we'll find out what the computer thinks it is."

"I'll bet it's a weapon of some sort," said Montresig. "They're almost always fighting down there according to the data we have and there's frequent mention of a device called a hydrogen bomb. If it's what I think it is I have no desire to visit them in person."

A figure detached itself from the group of men surrounding the huge contrivance and came hurrying to the elevator entrance beneath the balcony. In a moment he appeared on the balcony, burped perfunctorily, and handed Commander Losure several sheets of script. The Commander read them into a microphone grill which was part of the remote panel feeding into the main computer. He waited until a red light glowed, indicating that the material had been integrated. He pressed a stud and spoke into the microphone again. "Classify," he said.

"Information in storage banks reveals object to be a gun," said the loudspeaker. "Gun: an instrument variously known as revolver, heater, rod, betsy, automatic, typewriter, gat, which refer to. Carried by gunmen, cowboys, mobsters, killers, cons, doughboys, cops, G-men, marines, gangsters and kids, which refer to. Weapon fires projectile

known as bullet, lead, shell, slug, which refer to. Solid projectile pierces body of individual causing serious injury and death. It is used with that intention. No information on size of instrument previous to captured specimen which is nearly fourteen zeng ... about five and a quarter man-lengths ... long. Sample excerpt demonstrating use: 'Blinky snapped the gun from his holster and fired from the hip. (sound of explosion) The big cowpoke grabbed at his chest and blood spurted between his fingers. With a look of surprise on his face he slumped to the barroom floor.'"

"What do you make of that?" asked the Commander.

"I'd have been surprised, too," said Montresig.

"They're bloodthirsty giants," said the anthropologist. "If that's a pocket weapon they'd be so big you couldn't get one into this hold.

"I don't believe it," said the Commander. "I think there's something wrong somewhere. Possibly guns come in various sizes. This could be a stationary weapon, perhaps, to blow buildings apart instead of people, though I can't figure out why anybody would want to. I'm going to send the dredge back once more to make sure we aren't being misled."

"I think you're wrong," said Montresig. "All evidence does point to a race of giants, evil creatures at best, even if maybe they do have two eyes, a nose and a mouth like us. Not that I don't think it's a good idea to send the dredge back," he added hastily at the sight of Commander Losure's glowering countenance.

The Commander signaled to the dredge operator again and they waited while he returned the gun to wherever he got it and fished for something else from the surface of the green planet.

The anthropologist cleared his throat. "You can't deny that the telescope shows us the most gigantic cities to be found anywhere in the galaxy."

"That doesn't necessarily mean that the inhabitants are physically large, only that there may be a lot of them," said the Commander.

"Or both."

Their attention turned to the floor of the hold as the opaque cloud rapidly grew darker and vanished again with a snap.

Montresig's reaction was the same as before.

"Great Shades of My Holy Ancestors," he said. "What is it?"

"It is assuredly an animal," said the Commander, "not unlike some we have on our own planet. I'll have the biologists and medics examine it." He turned to the anthropologist. "You go, too, Alfvis."

The animal, which had appeared stunned when it first appeared, now began to turn around, making clicking noises on the floor. As the men approached it from all directions it looked about nervously, opened its mouth to show some glistening teeth and proceeded to make a long, harsh noise. Alfvis made the mistake of approaching too closely to the beast which wheeled and kicked him head over heels some distance away. Montresig touched a red button on the railing and stasis beams converged on the animal freezing it instantly. It toppled over and lay stiffly on the floor of the hold. Alfvis dragged himself to his feet and shouted up to the balcony. "Ask the computer about animals with long ears."

The Commander spoke into the microphone again. "Four-legged animal, long ears. Classify."

"Rabbit," said the computer. "An animal variously known as bunny, hare, coney, peter, uncle wiggly. Strong rear legs. Progresses over ground erratically. Consumes vegetation. Multiplies with great rapidity. Lays egg at Easter Time. It is generally considered timid and is hunted for food. Sample excerpt demonstrating relationship: 'Lon climbed over the stone wall and continued across the woodlot towards his cabin, the carcasses of three rabbits slung over his shoulder ... there would be rabbit stew tonight.'"

"Holy Gods in Their Celestial Quarters," said Montresig. "Did you hear that? Is there any question in your mind now about the size and ferocity of these people?"

"Considerable," said the Commander. "That computer has made mistakes before, witness that last planet. Those were supposed to be garden snails, those slugs that gave us such a walloping. I don't think we get the right information through to it."

"But Your Loftiness," wailed Montresig, "everything adds up, you can see for yourself ... their giant cities, their warring on each other,

the information the computer gave us ... it isn't safe to land on that planet."

"No, I suppose not," sighed the Commander. "But do you realize the implications? Here we have a highly advanced race just ready to take off into space ... and according to our information they are savage war-making giants. If I bring that news back our Supreme Goodness is apt to issue orders to evacuate several hundred planets and move to some other galaxy--Let's try the dredge once more."

Commander signaled the dredge operator and waited a reasonable length of time before he was informed that something was wrong with it and that it would be some time before repairs could be made.

"I give up," said Commander Losure. "I have orders not to land on a questionable planet and I've learned my lesson. Either that computer has a few loose connections or those people are broadcasting pure nonsense. I just don't believe in giants, much less in scientific ones. Get ready to leave, Montresig, and see that you make an accurate written report of this whole situation."

"What do we do with the animal, Your Loftiness?"

"The dredge is busted, so what do you think we can do with it? Heave it out the airlock. It can stay here on the moon until the first explorers come up from the planet, which won't be long, and they can have rabbit stew."

The great ship lifted from the dark moonscape, leaving behind the frozen form of the first earth being to have crossed space, a surprise for the crew of the first manned moon rocket, if not the makings of rabbit stew.

Somewhere, a million miles beyond the sun, the ship accelerated rapidly. The Commander looked up from his desk as Montresig entered smartly with a precision burp.

"Alfvis is back in the freeze locker and repairs are going forward on the dredge, but it'll be a long job."

"It doesn't matter," said the Commander. "We're going home. I'm committed to bringing back a report on this planet now, but I don't like it and will advise further study of it by other expeditions before any desperate measures are taken such as evacuating the galaxy."

"It's funny about that rabbit," said Montresig. "I noticed as we shoved it out the lock that it had semi-circles of some hard metal, probably iron, nailed to its feet."

"That is peculiar," said the Commander. "Almost like the shoes we attach to the feests' hooves before the children ride them. Just for the fun of it, Montresig, why don't you give that information to the computer and see what it says?"

"Can't," said Montresig. "I wiped the memory tanks clean. I don't think it means much, anyway; a rabbit's a rabbit, shoes or no shoes."

The Commander nodded and Montresig burped and withdrew.

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Cover art:

English: American (top) and Chinese (bottom) alligators

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